Attorney Docket 183-U.S.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#3

Applicant:	Algirdas A. Underys	)	Attention:
		)	
Serial No.:	08/991,113	)	**Primary Examiner**
		)	**Wyszomierski**
Filing Date:	December 16, 1997	)	
		)	Group 1742
Title:	**Heat Treatment Method and Apparatus**	)	
		)	

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The Honorable Commissioner
of Patents and Trademarks
Washington, DC 20231

ON APPEAL
Appeal No. 2001-0359
(Formerly Appeal No. 10,359)

LETTER

TRANSMITTING APPEAL BRIEF AND REQUESTING EXPEDITED STATUS

Submitted concurrently with this submission are three copies of applicant's brief and an amendment cancelling claim 7.

A brief filing fee is not included since applicant paid the appeal brief filing fee on June 28, 2000, as will be apparent from the attached copy made from applicant's file of "Letter Transmitting Fee For Filing Appeal Brief Pursuant To 37 C.F.R. 1.17(c)".

It is noted for the benefit of the Clerk of the Board of Appeals that this second appeal brief has been necessitated by the fact that the application was remanded by the Board to the Examiner without a decision on the merits and with directions for further proceedings, which further proceedings have resulted in this second appeal brief.

Since a perusal of the Board's decision of July 18, 2002, to remand the application to the Examiner will disclose that said remand was not attributable to applicant, it is requested that this appeal be expedited by being credited with the date of the original Notice of Appeal, namely December 16, 1999, and not the date of the renewed Notice of Appeal of approximately March 17, 2003 (applicant has not yet received the return self-addressed postcard which accompanied said renewed Notice of Appeal).

Respectfully submitted,

A. Finkl & Sons Co.

By: James G. Staples, Esq.

Its Intellectual Property Counsel

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Serial No.:	08/991,113	)	**Primary Examiner Wyszomierski**
Filing Date:	December 16, 1997	)	Group 1742
Title:	**Heat Treatment Method and Apparatus**	)	

The Honorable Commissioner
of Patents and Trademarks
Washington, DC 20231

ON APPEAL
(No Appeal Number Assigned)

LETTER TRANSMITTING FEE FOR FILING APPEAL BRIEF PURSUANT TO 37 C.F.R. 1.17(c)

A check in the amount of $150 (small entity) is submitted herewith in connection with filing an appeal brief pursuant to 37 C.F.R. 1.17(c), together with a duplicate original of this Request and an appeal brief in triplicate.

Respectfully submitted,

James G. Staples

James G. Staples, Esq.
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Case 183' U.S.

Case 183- U.S.

THE UNITED STATES PATENT OFFICE IS REQUESTED TO IMPRESS ITS STAMP ON THIS CARD AND PLACE SAME IN THE OUT-GOING MAIL TO SHOW THE FOLLOWING PAPERS HAVE BEEN RECEIVED. IN RE PATENT APPLICATION 08/911,113

OIPE JC147
JUN 2 8 2000
PATENT & TRADEMARK OFFICE

1) Appeal Brief - in triplicate
2) Letter Transmitting Fee for Filing Appeal Brief Pursuant to 37 C.F.R. 1.17(c) and check no. 4815 for $150
3) Request for Extension of Time of One Month to File Appeal Brief Pursuant to 37 C.F.R. 1.17(a)(1) and check no. 391538 for $55

Attorney Docket 183-U.S.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Algirdas A. Underys	)	Attention:
Serial No.:	08/991,113	)	**Primary Examiner Wyszomierski**
Filing Date:	December 16, 1997	)	Group 1742
Title:	**Heat Treatment Method and Apparatus**	)	

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ON APPEAL
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(Formerly: Appeal No. 10,359)

APPEAL BRIEF

I. Real Party in Interest

A. Finkl & Sons Co., assignee of the applicant.

II. Related Appeals and Interferences

None.

III. Status of Claims

Apparatus claims 10-14 are withdrawn pursuant to a requirement to restrict.

Method claims 1, 2, 3, 5, 17 and 18 have been cancelled.

Method claims 4, 6, 7, 15, 16 and 19 are rejected under 35 U.S.C. 112, first paragraph.

Method claims 8 and 9 are objected to since they are dependent claims which depend

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from rejected claim 15, but are otherwise allowable, Paper No. 25.

IV. Status of Amendments

Three Office Actions and two applicant submissions followed the first opinion of the Board of Patent Appeals and Interferences (hereafter the "Board") in this application, said decision being dated July 18, 2002, Paper No. 24.

In the first post-Board action, the Office Action dated August 5, 2002, Paper No. 25, the Examiner withdrew all rejections which had formed the basis for filing the appeal (i.e.: a 35 U.S.C. 112 rejection), and rejected, for the first time, claims 4, 6-9, 15, 16, 17 and 19 on the grounds of "the judicially created doctrine of obviousness-type double patenting ... over claims 1-13 of U.S. Patent No. 6,398,855". This was a non-final rejection.

In response to the August 5, 2002, Office Action, applicant submitted a paper entitled "Amendment", probably Paper No. 26, in which applicant argued that none of the double patenting rejections in the August 5, 2002, Office Action were sustainable. No changes were made to any of the nine rejected claims. Said Amendment was filed October 17, 2002.

In response to the October 17, 2002, Amendment, the Examiner, on January 6, 2003, finally rejected seven claims, namely 4, 6, 7, 15-17 and 19, and objected to claims 8 and 9, indicating, on page 6, of said January 6, 2003, Office Action, that claims 8 and 9 would be allowed if rewritten in independent form.

In an effort to resolve the issues without pursuing a further appeal the applicant, on February 3, 2003, submitted a "Remarks-Responsive To January 6, 2003 Office Action", probably Paper No. 28, said remarks being confined to the seven rejected claims 4, 6, 7, 15,

16, 17 and 19. No claim changes were made.

In response to the February 3, 2003, "RRTJ 6, 2003", the Examiner issued an Advisory Action, Paper No. 29, in which he adhered to the double patenting rejection of the seven claims 4, 6, 7, 15, 16, 17 and 19.

On March 17, 2003, applicant requested reinstatement of the appeal by filing a "Notice of Appeal" of the seven rejected claims which was the second such paper with that heading.

Submitted concurrently with this Appeal Brief applicant has submitted an Amendment which requests cancellation of claim 17. As a result therefore no portion of this Appeal Brief is directed to said claim 17.

V. <u>Summary of the Invention</u>

The invention is a method of heat treating tool steel workpieces (p. 1, line 8; p. 3, lines 3, 4)), namely rods, bars and blocks (p. 4, lines 3-7), in conventional heat treatment furnaces (p. 3, lines 14, 15). It is essential that the heat be applied all the way through the workpiece; i.e.: to the center thereof, in order to achieve the aimed for beneficial effects of the heat treatment; that is, heating the surface or only a region near to and including the surface is <u>not</u> desired (p. 4, lines 2-13). The heat is applied by subjecting the tool steel workpieces to infrared heat energy up to 5000°F (p. 4, lines 15, 16) generated in tungsten halogen tubes having a tungsten heating element and a halogen gas within a sealed quartz tube (p. 4, lines 13-16). The tungsten halogen tubes are operated in a furnace environment (p. 3, lines 9-11). The furnace walls may have a high reflective surface formed by a thin

coating of gold, silver or aluminum on the interior of the furnace walls (p. 3, lines 16-18). The workpieces are supported in the furnace on ceramic or other high melting point support structures (p. 4, line 1).

See also original claims and the abstract.

There is no drawing.

VI. ISSUES

Is any one of claims 4, 6, 7, 15, 16 or 19 rejectable on the ground of the judicially created doctrine of obviousness type double patenting over claims 1-13 of U.S. Patent 6,398,855?

VII. GROUPING OF CLAIMS

Claims 6, 7, 15 and 16 stand or fall together since the Examiner stated that, with respect to said claims:

> "The difference between the instant claims and the '885 claims is that the '885 claims recite a number of limitations which are not recited in the instant claims. However, none of these limitations are inconsistent with the presently claimed process, and it appears that carrying out any process as defined in the '885 claims would necessarily produce a result in which one also carries out the process as defined by the present claims. Consequently no patentable distinction is seen between the presently claimed process and that of the '885 patent", para "2",

paper no. 27.

Claim 4 stands by itself since, with respect to said claim, the Examiner said any one of the '885 claims, when considered with the reflective surfaces of McGinty or Heath, "would have rendered it obvious to one of ordinary skill in the art to utilize the presently claimed reflective surfaces when performing the process according to (any one of) the '885 claims", para "3.", paper 27.

Claim 19 stands by itself since, with respect to said claim, the Examiner said any one of the '885 claims, when considered with the gold plated reflective wall disclosure in McGinty, would have resulted in the conclusion that "to use such a surface in the process as defined by the '885 claims would have been considered an obvious expedient by one of ordinary skill in the art", para. "5., paper 27.

VIII. ARGUMENT

Background

To provide the Board with background we believe will be helpful in resolving the issues we point out the following.

The disclosure of applicant's '885 patent has two effective filing dates, one (January 11, 1996) which is before the filing date of the instant application, and the other (September 25, 1998) which is after the filing date of the instant application.

At this point we assume the Board has read the '885 patent and the instant application.

Attachment 1 attached hereto is a copy of the "shank softening" treatment application S.N. 08/582,373 of inventor Finkl which was filed January 11, 1996; i.e.: before the filing

date of the instant application. Note that Finkl application 08/582,373 discloses the embodiments of Figures 1-5 of the '885 patent, the basic -- and sole -- inventive concept of said 08/582,373 application being the application of heat to one small two inch think portion of one big piece of tool steel by an induction coil to end up with (i) a soft portion (into which a shank can be formed by machining to eliminate cracking at the resulting shank-body fillets) and (ii) a hard portion which is unaffected by the induction coil; it has had built into it the desired final properties, almost always hardness, and is the working portion of the block of tool steel. The Board will further note that there is no reference to infrared heating in this earliest application.

The instant application ,which discloses the basic -- and sole -- concept of the use of infrared heat to condition the entire volume of a block of tool steel, invariably to harden it, using infrared heating, was the next filed application on December 16, 1997.

Attachment 2 attached hereto is the '885 patent which was the next filed application on September 25, 1998; i.e.: nine months after the filing date of the instant application, and is, like its 1996 parent 08/582,373, limited to the basic -- and sole -- inventive concept of applying of heat to a small, confined area of one big block of tool steel by either an induction coil or infrared heat to end up with (i) a soft portion (into which a shank can be later machined to eliminate cracking at the shank-body fillets) and (ii) a hard portion which is unaffected by the applying of heat to the confined area and has had built into it the desired final properties, almost always hardness, which is the working portion of the block of tool steel.

The real world situation is obvious: Inventor Finkl was concerned with the problem of cracking at the fillet between the shank and body portion of a die block. He conceived using an induction heating coil to soften the top two inches of a die block, leaving the remaining bulk of the block with all the final properties which had been built into it through heat treatment, and in 1996 filed application 08/582,373 thereon. Thereafter inventor Underys addressed the broad problem of heat treating tool steel blocks in their entirety by the use of infrared heating, thereby eliminating the decades old practice of burning coke oven gas, natural gas, propane and butane in the furnace, see Attachment 3, p. 1062, and developed the invention disclosed in the instant application, and filed his application thereon, the instant application, in 1997.

Some time later in 1998 inventor Underys, working with inventor Finkl, concluded that the concept of the use of infrared heating of entire die blocks, which had been developed by inventor Underys in 1997, could be applied to only a portion of a die block and thus address the problem of shank cracking -- which occurred in a small portion only of a die block, leaving the balance of the die block, the larger working portion, unaffected because it contained, at the start of the treatment of the shank portion, all of the desirable qualities which had been built into the block by earlier treatment.

Therefore, the two inventors, after realizing that Underys' full block infrared process could have application to Finkl's shank-block fillet cracking problem, filed the application which matured into the '885 patent in 1998.

With the above in mind it will be seen that the relationship, if any, of Underys' sole

application -- the instant application 08/991,113 -- to the later Finkl-Underys application, now the '885 patent, is broad to specific. Yet claims 6, 7, 15 and 16 of the broad early application are rejected solely on a later filed specific application.

We know of no authority to support this proposition and the Examiner has cited none.

To the contrary, there is considerable authority to the effect that a later filed specific application which matures into a patent before an earlier field broad application cannot be the basis for a rejection of the earlier filed application. Chisum on Patents, Vol. 3, 2002, §9.03[2][c] Generic Claim Issuing After Later Filed Specific or Improvement Claim.

> "In resolving the problem, the courts reasoned in effect that the order of issuance should be disregarded in this special situation and the later issuing generic patent should be upheld if the improvement is patentably distinct from the generic invention. In re Borah, 354 F.2d 1009, 148 USPQ 213, (CCPA 1966); In re Stanley, 214 F.2d 151,102 USPQ 234 (CCPA 1954)."

<u>With Respect to the Rejection of Claims 15, 6, 7 and 16</u>:

I. In the January 6, 2003 Final Rejection the Examiner held that claims 6, 7, 15 and 16 were unpatentable over claims 1-13 of the '885 patent because, although the claims were not identical, they were not "patentably distinct" because both were "drawn to methods for treating tool steel blocks by ... subjection to the effects of infrared radiation ... and it appears that carrying out any process as defined in the '885 claims would necessarily produce a result in which one also carries the process as defined by the present claim." In paragraph "1)" of

the February 21, 2003 Advisory Action he put it more succinctly: "If one carries out a process as defined in the claims of the '885 patent, then one necessarily carries out a process as defined in the present claims."

With respect, the Examiner misapprehends the characteristics of the two sets of claims. Specifically: Claim 1 of the '885 patent states:

a) "providing a pre-hardened die block having ... opposite sides being the working side and the mounting side" with the "mounting side having a depth of about two inches",

b) thereafter "treating said two inches deep ... portion by subjecting it to an electrical source of heat",

c) and, also, "subjecting the remaining portions of the fully hardened die block which are not exposed to the electrical source of heat to ambient conditions, including ambient atmosphere, while said treated portion is subject to said electrical source of heat", all for the goal of making a block having a soft portion and a hard portion.

This accurately describes the plate heater shown in Figure 6 of the '885 patent and the two regions of hardness shown in Figure 7.

In diametric contrast, broadest claim 15 of the instant application requires:

a) "providing a heat treatment furnace" having "a source of infrared heat energy", and

b) "subjecting the tool steel workpiece to heat treatment ... from the infrared energy source." The "heat treatment furnace" is a conventional, existing heat treatment furnace as is clear from lines 14 and 15 of page 3 of the

specification:

> "... existing heat treatment furnaces can be used with little or no modification ...", that is, an enclosed structure having an up and down (or side to side) door which opens to load and unload a charge and in which the heat is dispersed throughout, see Attachment 3, pp. 1062, 1063. Indeed to further assist dispersal of heat "A thin coating of gold, or silver, or aluminum over some or substantially all of the interior surfaces of the furnace will be quite suitable." lines 17, 18, page 3.

There is no metallurgically visualizable way in which a tool steel workpiece treated in an existing, enclosed furnace modified only to have infrared energy substituted for the conventional gas burner (i.e.: the instant application) can be said to be treated to a depth of "two inches" while at the same time "subjecting the remaining portions ... which are not exposed to the electrical source of heat to ambient conditions, including ambient atmosphere, ..." as required in broad claim 1 of the '885 patent. In other words the heat-one-portion-while-cooling-another-portion of the workpiece described in claim 1 of '885 finds no response in the instant claims 15, 6, 7 and 16 which describe only treatment by heat of the entire workpiece.

II. The invention claimed in claims 15, 6, 7 and 16 on the one hand and claims 1-10 of the 885' patent on the other hand are patentably distinct because:

A. The physical objects which are the subject of treatment are different;

B. The starting condition of the physical objects to be treated is different;

C. The extent of physical involvement of the objects being treated is different;

D. The treatments applied to the two physical objects are different (due to the differences between the two treating apparatuses);

E. The environments in which the two treatments are carried out are different; and

F. The final products resulting from the two dissimilar treatment processes are different.

A. The physical objects which are the subject of treatment are different.

We refer to claim 15 of this application, see Attachment 4, and claim 1 of the '885 patent, see Attachment 5, as illustrative of this group of claims.

Claim 15 is directed to "heat treating" of rod, bar and block tool steel. The phrases "heat treatment" and "heat treating" in claim 15 is defined in the specification of this application as conventional heat treatment (p. 1, line 8; p. 3, lines 3, 4, 14, 15; p. 4, lines 3-7); that is heating a rod, bar or block all the way through for some purpose -- usually, as those skilled in the art will affirm, to harden or stress relieve the entire workpiece, i.e.: the center as well as the outer portions. See further page 1, lines 13-19 in which removal of the decarburized layer which is present on all surfaces following heat treatment -- is disclosed.

> "With respect to equipment it is believed that existing heat treatment furnaces can be used with little or no modification, or preferably, with selective modification."

It is well known to those skilled in the art that "existing heat treatment furnaces" means large, closed containers in which the heat, by whatever means generated (usually gas jets), completely envelopes the workpiece undergoing treatment. See Attachment 3 and also page 4, lines 5-7 of the specification:

> "By the same token, if a block having a 10" by 10" cross-section is to be heat treated a substantially <u>longer processing time will be required due to the time lag of the temperature rise in the center of the workpiece</u>." (emphasis added)

By contrast, claim 1 of the '885 patent refers only to the "shank portion of a pre-hardened die block".

In other words, claim 15 refers to treatment of the <u>entirety</u> of rods, and bars, and blocks whereas claim 1 of the '885 patent deals with treatment of only a <u>portion</u> (i.e.: two inches is specifically claimed) of a die block. Rods, bars and blocks are not the same thing as, and do not equal, the "shank portion of a die block", and a "block" standing alone does not equal the "shank portion" of a die block. We call the Board's attention to the fact that there are a myriad of blocks known in the steel industry: sow blocks, hammer blocks, bull blocks, motor blocks, double-deck blocks, wheel blocks, drawing blocks to name a few, and "a shank portion of a ... die block" cannot possibly be equated with any one of the above

listed blocks.

Hence the physical object which is the subject of treatment in application claim 15, and also claims 6, 7 and 16, on the one hand, and claim 1 of the '885 patent on the other hand, are different, and since the physical object of the broadest claim in the application product is different from the physical object of the broadest claim in the '885 patent, it follows that all claims of this group are different from all other claims (2-10) of the '885 patent.

B. The starting condition of the physical objects to be treated are different.

We again refer to claim 15 of this application and claim 1 of the '885 patent.

Claim 15 is directed to "a rod or bar or block" without further specification as to its condition. Claim 1 of the '885 patent by contrast is directed to a "pre-hardened die block having a working side and a mounting side".

A piece of steel which has been "pre-hardened" means, to a man skilled in the art, that the piece, after melting and cooling, has been subjected to heat to bring the piece to a desired level of hardness all the way through. In other words, the piece of steel in claim 1 of the '885 patent starts treatment in its final, hardened condition. By contrast, the steel in claim 15 of the application starts in an unspecified condition; it may be soft, it may be hard, it may be at some intermediate processing stage. The Examiner will note that, to a man skilled in the art, the words "heat treating" are assumed to mean, unless specifically contradicted, that the steel is in quenched condition and that heat is being applied to it for the dual purpose of relieving internal quenching stresses and of achieving a desired hardness level.

Thus claims 15, 6, 7 and 16 refer to steel in any condition whereas claim 1 of the '885 patent specifically requires that the steel be in a <u>hardened</u> condition.

Since claims 2-10 of the '885 patent add further limitations to claim 1 therein, it follows that said claims 2-10 are even more remote from the claimed process of claims 15, 6, 7 and 16.

C. The extent of physical involvement of the objects being treated are different.

We again refer to claim 15 of this application and claim 1 of the '885 patent.

Claim 15 of this application requires the providing of "a heat treatment furnace of a size suitable to receive a tool steel workpiece to be heat treated". In other words the whole workpiece is subjected to treatment. By contrast in claim 1 of the '885 patent, only the "mounting side" of the workpiece "having a depth of about 2 inches extending in a direction toward said working surface" is subjected to treatment. In other words <u>all</u> of the workpiece in application claims 15, 6, 7 and 16 are subjected to treatment whereas only a small, specific portion, less than all, of the workpiece in claim 1 of the '885 patent is subjected to treatment. There is no teaching or suggestion in claim 1 of the '885 patent that all of the workpiece could or should be subjected to treatment. Indeed, to subject all of the workpiece in claim 1 would totally defeat the purpose of the '885 patent because to do so would result in a 100% softened final product whereas the aim of the '885 patent is to produce a final product having a hard portion and a soft portion, both portions being intended to perform a separate and distinct function. Thus, patent claim 1 contains a teaching directly contrary to the through

hardening of application claim 15.

<u>D. The Treatments applied to the two physical objects are different.</u>

Claim 1 of the '885 patent requires that all <u>but</u> the treated portion of the workpiece be subjected "to ambient conditions, including ambient atmosphere". By contrast, the tool steel workpieces of claims 15, 6, 7 and 16 are treated in a conventional furnace and, even if the conventional furnace is leaky, it cannot be said by any stretch of the imagination that the physical objects of claims 15, 6, 7 and 16 are treated in the presences of "ambient atmosphere". In essence there is no disclosure or suggestion within the four corners of claim 1 (or any other claim) of the '885 patent that <u>all</u> of the workpiece in claims 15, 6, 7 and 16 should be <u>only</u> treated in a partial area thereof; indeed the whole rationale for claim 1 of the '885 patent is to finish with a <u>differential</u> hardness in a workpiece; application claims 15, 6, 7 and 16 contain no such limitation.

<u>E. The environments in which the two treatments are carried out are different.</u>

In the method of claim 1 of the '885 patent the workpieces undergoing treatment are subjected to two different treatment environments: firstly, a two inch deep first portion (lines 1-4, col. 10) is subjected to a very high treatment temperature which initially entails a very hot, non-ambient atmosphere adjacent that two inch deep portion and, secondly, a second portion which is <u>not</u> exposed to the heat applied to the first portion, is subjected to "ambient conditions, including ambient atmosphere". By contrast, the workpieces in claim 15, 6, 7 and 16 in the application are subjected to a single treatment environment. By contrast, the

atmosphere found in a "heat treat furnace" is, as any man skilled in the art appreciates, a single treatment environment; usually the combustion products of coke oven gas, natural gas, propane or butane, but in no sense atmospheric, see Attachment 3, p. 1063.

In sum, there is no teaching or suggestion in the '885 claims that the two treatment environment system of the '885 claims should be modified to be a single treatment environment system of a heat treat furnace as required by claims 15, 6, 7 and 16.

F. The final products resulting from the two dissimilar treatment processes are different.

Claim 1 of the '885 patent is directed to treating only a portion, specifically the shank portion, which is opposite the hardened working surface, of a workpiece, so as to finish with a single object having two zones of hardness; one, the initial unchanged hardened condition and the other, the final softened condition of the two inch deep section as clearly specified in lines 17-20, col. 10 of claim 1 which speaks in terms of "said opposite portion is softened, as contrasted to the fully hardened working surface". By contrast the concept of differential hardness within the workpiece is nowhere even hinted at in the claims 15, 6, 7 and 16.

We call the Examiner's attention to the fact that a soft portion, for assuming shock loads, and a hard portion, for shaping rough workpieces, is the essential concept in claim 1 of the '885 patent, and nowhere within the four corners of claims 1-10 in the '885 patent is there a disclosure or suggestion that the entire final workpiece should have a uniform hardness.

We submit that claims 15, 6, 7 and 16 are patentable over any one of claims 1-10 of the '885 patent.

With Respect to the Rejection of Claims 4 and 19:

The invention of claims 4 and 19 of this application on the one hand and claims 1-10 of the '885 patent on the other hand are patentably distinct because:

A. The objects which are the subjects of treatment are different because, in sum, claims 1-10 of the '885 patent are directed to treating a specified portion of a workpiece (specifically two inches depth on the surface opposite the working surface) whereas application claims 4 and 19 are directed to treating the entire workpiece. In order to expedite consideration we here merely incorporate by reference II.A. above.

B. The starting conditions of the workpiece to be treated are different because, in sum, claim 1-10 of the '885 patent are directed to a workpiece which has been "pre-hardened" whereas, by contrast, in application claims 4 and 19 the workpiece starts the process in a non-final condition. In order to expedite consideration we here merely incorporate by reference II.B. above.

C. The degree of physical involvement of the workpieces being treated is different because, in sum, claims 1-10 of the '885 patent are directed only to treatment of two inches on one side of a workpiece whereas, by contrast, in application claims 4 and 19 the entire workpiece is subjected to treatment. In order to expedite consideration we here merely incorporate by reference III.C. above.

D. The treatment applied to the two physical objects are different because claims 1-10 of the '885 patent require that all <u>but</u> the treated portion of the workpiece be subjected "to ambient conditions, including ambient atmosphere" whereas, by contrast, the workpiece of application claims 4 and 19 are treated in a conventional furnace, and hence can in no sense be subjected to ambient atmosphere. In order to expedite prosecution we here merely incorporate by reference II.D. above.

E. The environments in which the two treatments are carried out are different because in claims 1-10 of the '885 patent the workpiece is subjected to a very high temperature over a two inch deep portion with the remainder being subjected to ambient conditions whereas, by contrast, in claims 4 and 19 no such starting condition can be reasonably inferred. In order to expedite prosecution we here merely incorporate by reference II.E. above.

F. The final product resulting from the two dissimilar treatment processes are different because claims 1-10 of the '885 patent treats only the shank portion of a workpiece so as to finish with a final product having two zones of hardness whereas, by contrast in application claims 4 and 19, the end result of different zones of hardness in the same unitary physical object would be directly contra to the end result. In order to expedite prosecution we here merely incorporate by reference II.F. above.

The McGinty and Heath References Are From Non-Analogous Art and May Not Be Used In a 103 Rejection.

A. We are cognizant of ¶804, II., B., 1., page 800-22, MPEP 8th Ed:

"Therefore, any analysis employed in an obviousness-type

double patenting rejection parallels the guidelines for analysis of a 35 U.S.C. 103 obviousness determination."

With the above in mind the issue with respect to claims 4 and 19 becomes: would a man skilled in the art of heat treatment of metal blocks of a size of, for example, 10" x 10" x 10", which are maintained stationary in a conventional heat treat furnace who sought to eliminate the conventional coke oven gas, natural gas, propane or butane furnace atmosphere while maintaining a uniform temperature environment naturally have turned to (a) Heath's "metal strapping wire", col. 2, line 29, having a thickness of between 0.015 "to 0.030", col. 9, line 3, which moves through a heating zone at "speeds of 110 to 150 feet per minute", col. 9, lines 2, 3 disclosure, or (b) McGinty's semiconductor, wafer, title, having a thickness of "100 mm", col. 5, line 59, which moves through its heat chamber "very rapidly" abstract, line 24, at the rate of "as little as 9 seconds ... to ... only 13.5 seconds", col. 5, lines 58, 59 and Figure 4. disclosure?

The answer is in the negative for the first reason that both McGinty and Heath are from non-analogous arts because neither, considering the subject matter with which it deals, logically would have commended itself to Underys attention in considering this problem, 2141.01(a)MPEP, 8th Ed, because there is no transferable practical knowledge derivable from the effects of applying heat to a thin strap or a wafer measured in millimeters or hundredths of an inch of thickness to a rod, bar, or block of steel measured in inches or feet of thickness and hundreds or thousands of pounds in weight. <u>In re: Clay</u>, 966 F.2d 656, 23 USPQ 2d 1058 (Fed. Cir. 1992) put it best:

> "The reference cannot be considered to be within [the inventor's] field of endeavor merely because both relate to the petroleum industry."

The answer is in the negative for the second reason that to combine the teachings of McGinty or Heath with claim 1 of '885 would have destroyed claim 1's viability since claim 1 teaches the production of a product having a non-uniform properties (i.e.: softness and hardness) whereas McGinty and Heath teach application of heat to achieve a uniform property.

In a word, McGinty and Heath are teachings directly contrary to the teachings of claim 1 of '885, and we see no need to cite authority for the proposition that references which contain opposing teachings are not fairly combinable in a 103 rejection.

Summary

In view of (i) the opposed teachings of the appealed claims and the '885 claims, (ii) the remoteness of the secondary references in the context of a 103 analysis, (iii) the explicit and/or implicit teachings in the claims of the '885 patent against the use of the teachings found in the secondary references and (iv) the non-analogous art status of the secondary references, it is, we submit, beyond reasonable argument that there is any disclosure or suggestion in the claims of the '885 patent to modify and supplement said claims as proposed in the January 6, 2003 and February 21, 2003 Office Actions, and hence withdrawal of the

rejections is requested.

Respectfully submitted,

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Attachment 1 - 14 pp.

METHOD AND APPARATUS FOR PREVENTING CRACKING OF THE SHANK JUNCTION OF DIE BLOCKS

This invention relates to a method and apparatus for eliminating or at least drastically reducing the cracking which today frequently occurs at the junctions of the body and shank of ferrous alloy die blocks and similar parts.

BACKGROUND OF THE INVENTION

Die blocks are well-known forging implements which, after the sinking of an impression therein to thereby form a die, are used in forging machines such as hammers. A hammer die, after final machining and heat treatment, if any, is then fitted to a die holder in the hammer. A typical hammer die has a large thick body (to provide for one or more resinkings of the impression) and, usually, a relatively short, dove tailed shaped shank located in the middle of one side of the body and extending the length of the body.

In operation a hammer die is exposed to extremely rugged conditions. In normal operations with all machine components properly positioned and secured, tremendous shock loads are transmitted to all portions of the die. Such loads, which are derived from the many tons of impact forces resulting from the weight of the downwardly driven ram portion of the hammer die striking the work piece resting in the die holder of the hammer die, have their greatest effect on the weakest portion of the die which, as is well known, is the junction of the shank and body of the hammer die. All too frequently the dies, which may range in hardness from about 28Rc to about 50Rc, are cracked or fractured at the shank-body junction of the die and this can lead to catastrophic failure.

Various remedies have been tried to eliminate or at least reduce cracking at the shank-body junction. It is known, for example, to avoid sharp corners at the shank-body junction and so radii of, for example, of about 2/10ths of an inch have been used at the shank-body junction.

Alternatively, or in conjunction with corner radii, the shank-body junction areas have been drawn in a salt bath of about 1250°F. Thus, and particularly for blocks which are about 42-46Rc or harder, one company has submerged the shank and a thin portion of the body in such a salt bath to get the notch area to about 38-40Rc as contrasted to the 42-50Rc of the balance of the die. Since the shank height may, for example, be on the order of about 2 inches, the drawing operation has been carried out by submerging 3-4 inches of the

hard, non-drawn die block, including the shank, in a salt bath at about 1250°F as above described in order to get the notch to about 1130°F, or about 38-40Rc, for one well known standard low alloy die steel of wide application which contains about .5 carbon.

The results of such treatment, while better than no treatment, are, in a sense, marginal since the process is difficult to regulate and measure with precision and a substantial element of judgment enters into the practice of the process, even on a day-in-day-out routine basis. Further, the process is lengthy, often requires the use of cranes or other auxiliary equipment to manipulate, hold and control the position of the die block during the salt bath treatment, requires the use of a hot liquid bath which is expensive to operate, having in mind such environmental factors as fumes generated by such baths, dangerous to shop personnel due to the high temperatures thereof, and yields less than consistent results.

There is therefore a need for a method and apparatus for preventing cracking at the shank-body junction of die blocks which is speedy in application, requires minimal handling of the die block to be treated, minimal auxiliary equipment during processing, eliminates the use of hot, liquid salt baths and with their above described drawbacks, and gives predictable and duplicatable results over the range of sizes, shapes, and compositions of die blocks currently produced.

SUMMARY OF THE INVENTION

The invention is an induction heating shank-body drawing system that eliminates the need for the currently used salt baths with their attendant drawbacks as described above, yet which can process all shapes, sizes and compositions of die blocks in a speedy, efficient and reproducible manner with consistent results, while requiring only a fraction of the cost of capital equipment and operating costs of salt baths, including savings in manpower, space and consumable materials.

Specifically the invention includes the use of paddle shaped induction heater means placed in operative contact with a ferrous, magnetic work piece and a non-magnetic enclosure, said paddle including induction heating coil means having a capacity to heat the critical areas of the die block to any desired depth and any degree of softness using well known operating parameters currently utilized in induction heating devices. Preferably a

die block is placed, in an inverted, shank down position, on a non-magnetic base and an induction heating paddle is placed in contact with the shank and each adjacent shoulder of the shank, the exposed portion of the paddle being blocked off with non-magnetic material. The water cooled copper tube induction coil, which is encased in a steel jacket, is activated for a sufficient period of time, depending on size, shape and composition of the work piece, to draw the shank-body junction area, and adjacent areas, to a condition in which cracking is either eliminated or drastically reduced as contrasted to the results currently achieved with salt baths.

DESCRIPTION OF THE DRAWING

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

Figure 1 is an end view of a current prior art process and system for eliminating cracking at the shank-body junctions of die blocks;

Figure 2 is a view of a conventional die block with which this invention may be used, the die block being illustrated in a shank up position;

Figure 3 is a perspective partly diagrammatic view of the induction heating paddle used in the invention;

Figure 4 is a partly schematic plan view of the system of the invention showing a conventional die block being treated; and

Figure 5 is a right end view of Figure 4 with parts omitted for clarity.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of the invention like reference numerals will be used to refer to like parts from Figure to Figure in the drawing.

Referring first to Figure 1 the current procedure, labeled Prior Art, for reducing cracking at the shank-body junction of a die block is there illustrated. A die block is indicated generally at 10, the die block having a shank 11 and a body indicated generally at 12. The die block is shown positioned shank down in a salt bath 13 held in tank 14. If the vertical dimension of the shank is about 2 inches, which is a conventional shank dimension of ferrous alloy die blocks currently intended for impact forging, such as hammer

machines, it will be noted that the depth of the bath is about 3-4 inches, and thus about 1-2 inches of the body 12 of the die block 10 is submerged in the bath 13. Since the block 10 can be quite large, for example two feet or more in width together with lengths into double figures, the block represents a very substantial heat sink. As a result, to heat a block, or several blocks if the tank 14 is to be used to capacity, a large number of calories will be absorbed by the blocks from the hot liquid and hence temperature measuring equipment must be used to continuously monitor the temperature of the bath, and provisions made to add heat to the bath, usually gas burners located beneath the tank. It will be seen that the shank-body junction on either side of the shank has had a fillet formed therein, indicated at 15 and 16. Even with such procedures and precautions, cracking remains a problem. A typical notch crack, as it is called, is indicated at 17. If the crack is severe enough it may extend all the way through to the die face 18 in which event the die is either a total loss or a large amount of rework, including welding and possibly even banding, must be performed, to put the die back into working condition. Even if the crack extends only part way into the body 12 and assuming the operator is alert enough to notice it after it begins, the die must be immediately taken out of production and reworked. Hence, down time with all the well known adverse consequences of lost production, are encountered.

A die block which, in this instance, does not have fillets at the shank-body junction is illustrated at 20 in Figure 2 with the shank up. The die block 20 includes a shank indicated generally at 21 and a body indicated generally at 22. The shank 21 may, for example, have a width 23 of about 4 inches with the left and right sides thereof having a dimension of about 2 inches, and shoulders, or die wings, 26, 27 of about 10-1/2 inches, so that the total width of the block is about 25 inches. The left and right sides 28, 29 of body 22 may be about 9-11 inches, for example, and the length of the sides 16 inches, though in actuality the length will vary widely. The above dimensions are only exemplary, and all of them may vary, though a typical range of the left and right sides of block 21 are on the order of about 2 inches to 3-1/2 inches. The length dimension of sides 28 and 29 may be of virtually any size, up to and including 8 or 10 feet. Alternatively, fillets may be formed at the shank-body junctions.

By way of comparison, in the salt bath system a rack is usually required for pieces up to about 8,000 pounds during treatment. Above this weight and size tongs,which are

controlled by a crane, must be used. As a consequence, for processing which requires a rack the piece dimension should have practical optimum measurements of about 26 inches wide by 48 inches in length by 22 inches in height, with an absolute maximum of about 28 inches wide and 50 inches long. If no rack is used the preferred optimum dimensions are about 38 inches wide by 48 inches long with an absolute maximum of 40 inches wide by 50 inches long. Although the above figures may vary to some degree from installation to installation they illustrate the fact that there is a practical maximum limit to the size dimensions which can be accommodated in the prior art salt bath system.

Referring now to Figure 3 an induction heating means which may be referred to as a paddle is indicated generally at 30. Paddle 30 is an induction heating coil system composed of a length of continuous, hollow copper tubing, indicated generally at 31, said tubing having an inlet 32, an entry run 33, a bend 34, a return run 35 and an outlet 36. The hollow, fluid tight tubing is enclosed in a steel jacket, indicated generally at 38, whose width and length dimensions can be of virtually any desired measurements and whose height can vary to a considerable extent. It will be understood that the longer the length the greater will be the heat generated, and hence either the greater must be the cooling water flow rate through the tubing, or the larger must be the diameter of the tubing so as to carry enough coolant to remove the heat generated during the process. It will be understood that the paddle may, if desired, be made in two longitudinal sections so that one or more intermediate, mating sections, each with its own length of copper tubing may be added to the paddle to increase or decrease its width as desired, the short lengths of tubing in the added sections being mated to ends of the copper tubing in bend 34.

Referring now to Figures 4 and 5 a specific system for processing die blocks, and particularly the shank-body junctions thereof, is there indicated generally at 40. The system 40 includes, in this instance, a large non-magnetic base, indicated generally at 41, resting on ground 42. The base may, for example, be granite or other rock like material which does not conduct electricity. Ceramic blocks similar to the bricks used in furnaces or ladles may, with suitable modification, be employed. The die block 20 is illustrated in a shank down position with the surface 23 of the die block resting on the upper surface 42 of base 41. A paddle 30 is disposed beneath, as viewed in Figure 5, with the die wing or right shoulder surface 27 at the right edge of base 41. The paddle 30 butts against a non-magnetic blocker

43. As a consequence, when the induction coil is energized the induction currents act only in the metal components, and specifically only in that portion of the body 22 which overlays paddle 30, and the adjacent metal of shank 21 and, thereby, the shank-body junction 44. A coolant system, including a pump P, is indicated generally at 45 for circulating coolant under suitable and conventional pressures in the copper tubing 31. The runs of the copper tubing are connected to the Power Source in a conventional manner. As an example, the application of 60 cycle current for from 15-30 minutes will usually be sufficient to raise the temperature of notches 44 or 49 to about 1130°F, which temperature, while sufficient to adequately draw the shank-body junction area, will not overheat a cavity which has been previously sunk in the die block. It will be understood that the term "draw" or "drawing" is used in this application synonymous with tempering which is carried out fundamentally for the purpose of precipitating iron carbide from martensite.

Although a single paddle which, in this instance spans the entire distance between the right side 29 of the body and the shank 21 has been shown, it will be understood that it may be more convenient in other setups to use two small paddles, or place a paddle on one side of die wing 27 and then the other side thereof. If desired, non-magnetic blockers may be used to fill the unused space if a paddle is used whose width dimension is shorter than the width of the die wing 27.

A support plate, preferably non-magnetic, is indicated generally at 46, the support plate having a height equal to the dimension of the left side 24 of the shank 21 so as to provide stability to the system. It will be noted that in such a setup, it is not necessary to use either a rack for processing, or tie up a crane and a pair of tongs during processing.

In this instance, the length of the die 20 is shorter than the length of the paddle 30. To maintain the integrity of the system a blocker 48 covers the exposed portion of the paddle. Preferably the blocker 48 is non-magnetic. Its dimensions should, preferably, be slightly greater than the exposed periphery of the paddle 30.

After the die wing 27 and shank-body junction 44 have been treated, the block may be lifted by any suitable means, such as tongs, rotated end-for-end, and thus the left die wing 26 brought into position over the paddle 30 so that said left die wing 26 and shank-body junction 49 may be treated in the same fashion as right die wing 27 and shank-body junction 44.

When the system is not in use, no equipment must be maintained and no special precautions need be taken to insure the safety of personnel in the area. The paddle 30 will promptly cool down to near room temperature after the power is shut off and the coolant circulated for a few minutes, and the heat pick up by the large granite non-magnetic base 41 and the blockers 43, 46 will be minimal.

It will thus be seen that a method and apparatus has been disclosed for preventing cracking at the shank-body junction of die blocks which is speedy in application, requires minimal handling of the die block undergoing treatment, eliminates the need for the use of auxiliary equipment during treatment, eliminates the use of hot, liquid salt baths with their attendant drawbacks including environmental concerns, and which gives predictable, and duplicatable, results over a wide range of sizes, shapes and compositions of ferrous alloys.

Although a preferred embodiment of the invention has been illustrated and described, it will at once be apparent to those skilled in the art that modifications may be made within the scope of the invention. Accordingly it is intended that the scope of the invention not be limited by the foregoing exemplary description but solely by the hereafter appended claims when interpreted in light of the relevant prior art.

CLAIMS

1. In a method of reducing the incidence of cracking at the shank-body junctions of die blocks, the steps of

placing an induction heating coil means in close, operative proximity to the body-shank junction of a die block to be drawn,

operating the induction heating coil means in the absence of any liquid medium in contact with the induction heating coil means,

confining the induction heating currents generated by the induction heating coil means to those portions of the shank and body of the die block which are to be drawn, including the shank-body portion on at least one side of the shank, and

terminating the operation of the induction heating coil means after the desired portion of the die block has been drawn.

2. the method of claim 1 further characterized in that

the means for confining the induction heating currents generated by the induction heating coil means includes at least partial envelopment by non-magnetic material of those portions of the induction heating coil means which are not in operative relationship with the shank or body portion of the die block.

3. The method of claim 2 further including the step of

treating the die block in a shank down position.

4. The method of claim 3 further characterized in that

the means for confining the induction heating currents are substances selected from the group consisting essentially of non-magnetic rock, rock-type and ceramic materials which are capable of withstanding, without substantial distortion, the temperatures generated during treatment by the induction heating coil means.

5. In a method of reducing the incidence of cracking at the shank-body junctions of die blocks, the steps of

placing an induction heating coil means in close, operative proximity to the shank-body junction of a die block to be drawn,

confining the induction heating currents generated by the induction heating coil means to those portions of the shank and body of the die block which are to be drawn, including the body-shank portion on at least one side of the shank, and

terminating the operation of the induction heating coil means after the desired portion of the die block has been drawn.

6. The method of Claim 5 further characterized in that

the induction heating coil means are in abutting contact with the shank-body junction surfaces of the die block.

7. The method of claim 6 further characterized in that

the thickness of the induction heating coil means equals the height of the shank of the die block.

8. Apparatus for reducing cracking at the shank-body junctions of a die block, said apparatus including, in combination,

induction heating coil means having at least a portion of its shape which conforms to the contour of the shank-body junction of a die block to be treated,

whereby, when said induction heating coil means is placed in operative position to draw the shank-body junction, said induction heating coil means will be in close, operative proximity to the shank-body junction, and

means for confining the induction heating currents generated by the induction heating coil means to those portions of the shank and body of the die block which are to be drawn.

9. The apparatus of claim 8 further characterized in that

the means for confining the induction heating currents generated by the induction heating coil means includes at least partial envelopment by non-magnetic material

of those portions of the induction heating coil means which are not in operative relationship with the shank or body portion of the die block.

10. The apparatus of claim 9 further characterized in that

the means for confining the induction heating currents are substances selected from the group consisting essentially of non-magnetic rock, rock-type and ceramic materials which are capable of withstanding, without substantial distortion, the temperatures generated during treatment by the induction heating coil means.

11. The apparatus of claim 10 further characterized in that

the induction heating coil means are in abutting contract with the shank-body junction surface of the die block.

12. The apparatus of claim 11 further characterized in that

the thickness of the induction heating coil means equals the height of the shank of the die block.

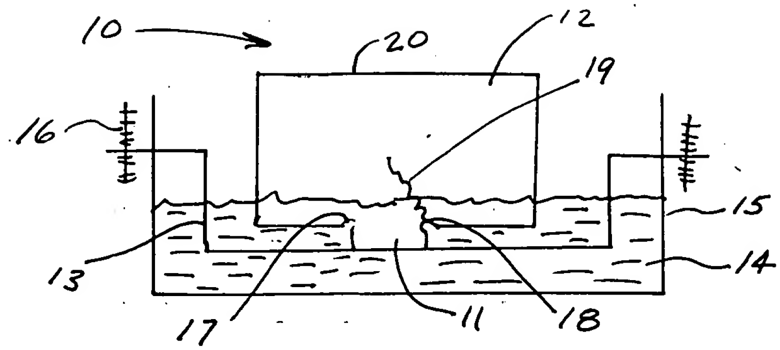

FIG. 1
(PRIOR ART)

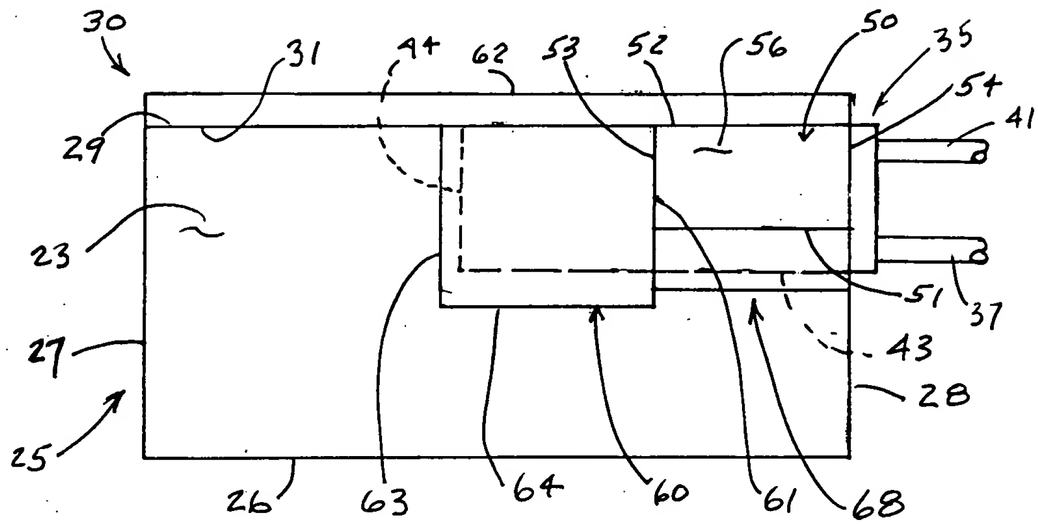

FIG. 2

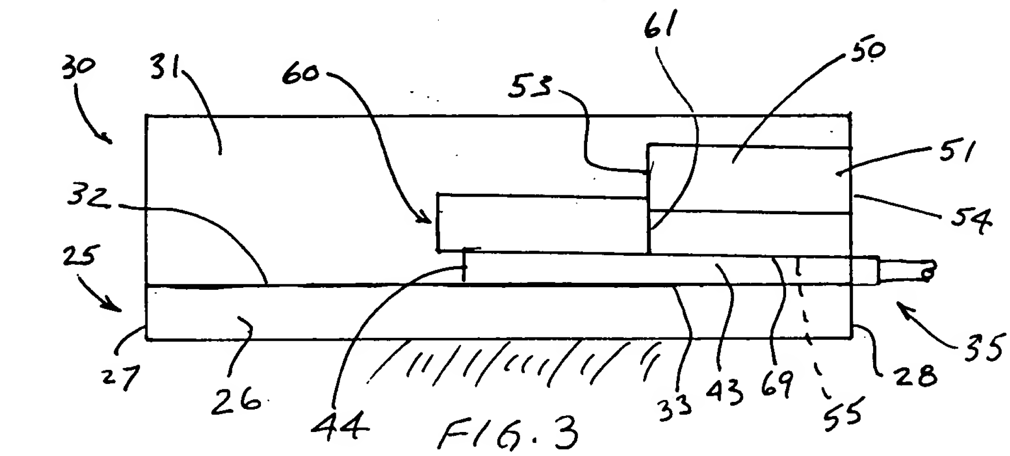

FIG. 3

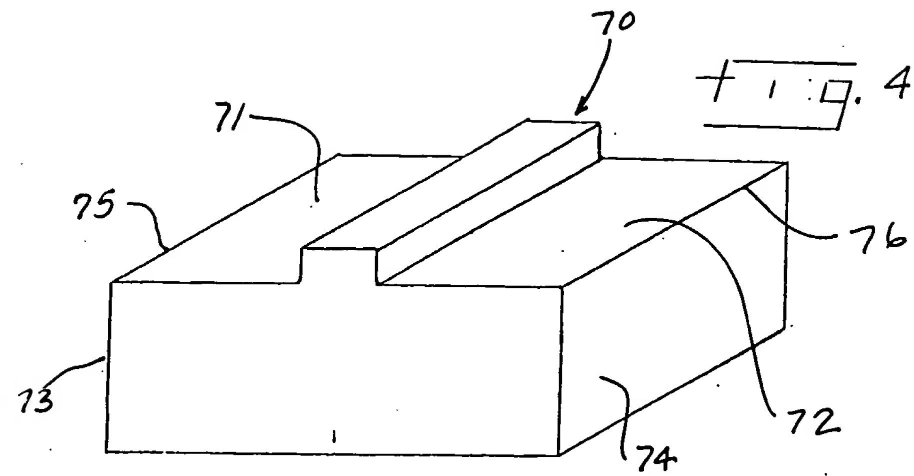

Fig. 4

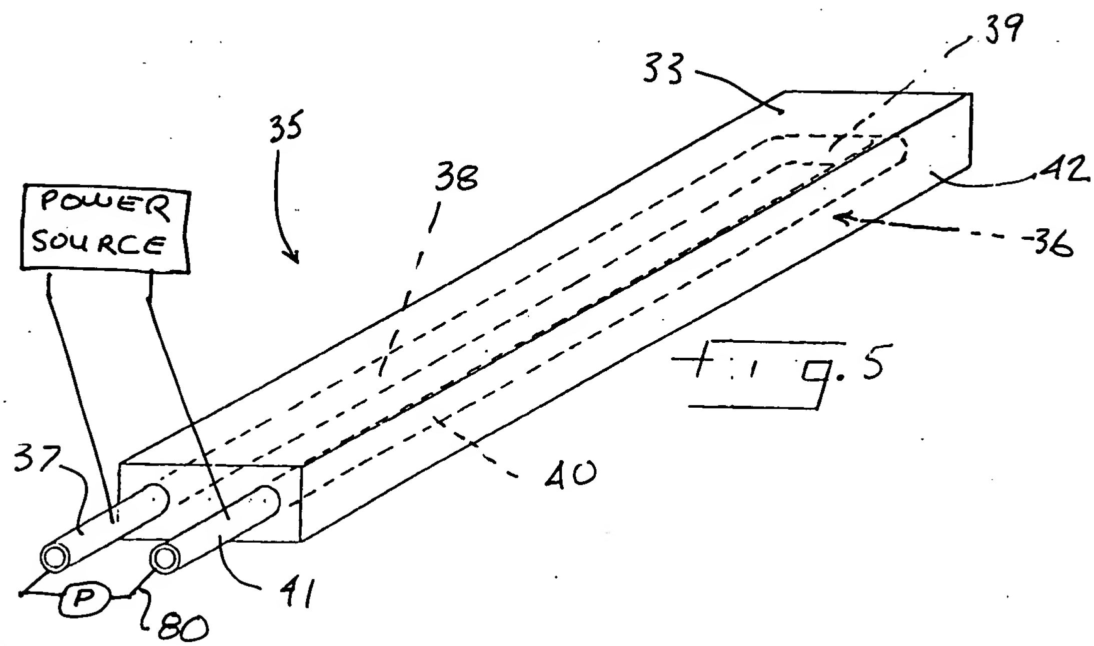

Fig. 5

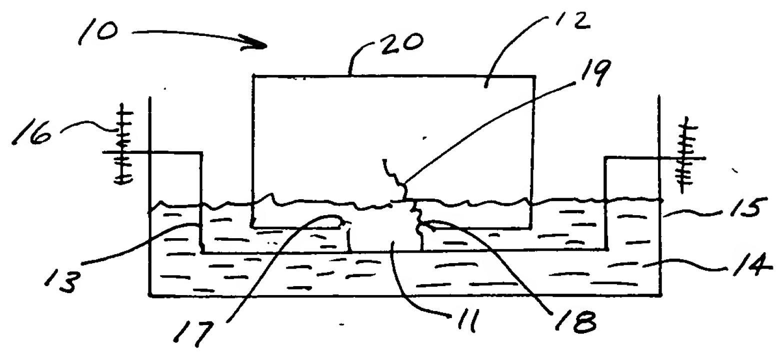

FIG. 1
(PRIOR ART)

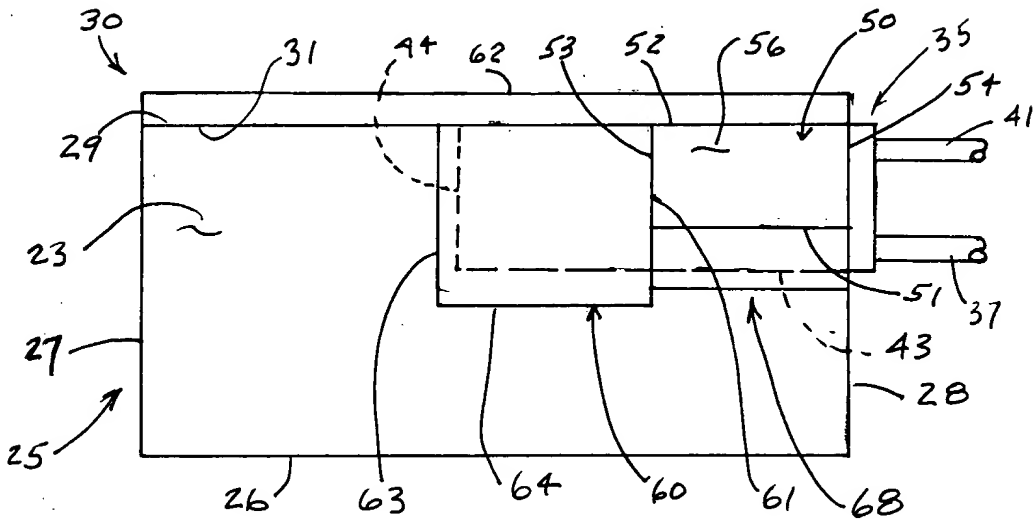

FIG. 2

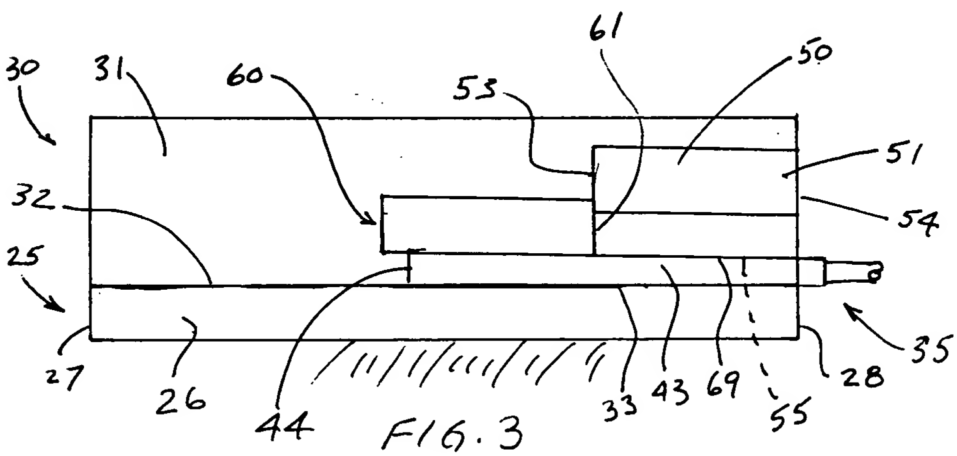

FIG. 3

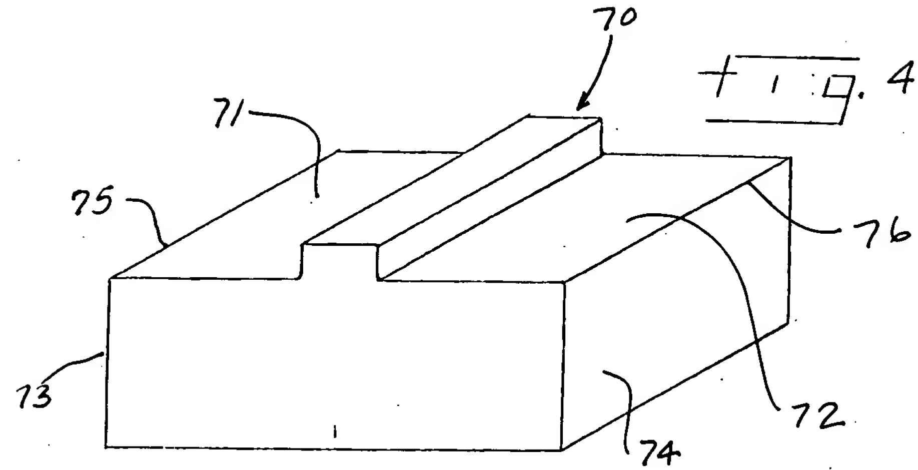

Fig. 4

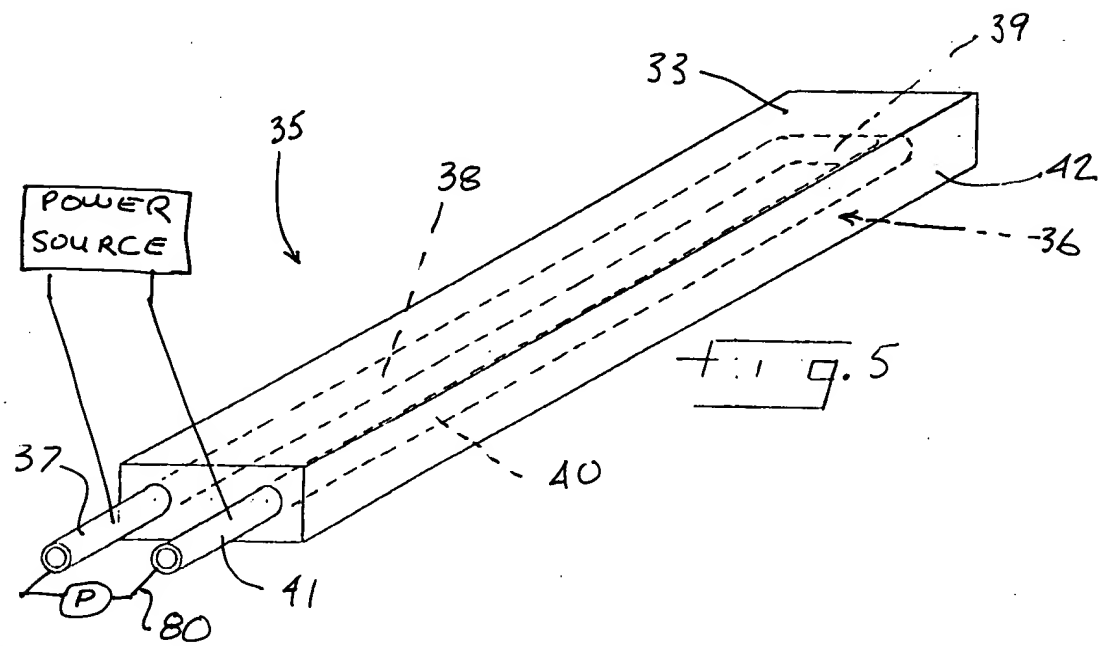

Fig. 5

US006398885B1

Attach- ment 2, 12 pp.

(12) United States Patent
Finkl et al.

(10) Patent No.: US 6,398,885 B1
(45) Date of Patent: Jun. 4, 2002

(54) METHOD AND APPARATUS FOR PREVENTING CRACKING OF THE SHANK JUNCTION OF DIE BLOCKS

(75) Inventors: **Charles W. Finkl**, Chicago; **Algirdas A. Underys**, Arlington Hts., both of IL (US)

(73) Assignee: **A. Finkl & Sons Co.**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/160,895**

(22) Filed: **Sep. 25, 1998**

Related U.S. Application Data

(63) Continuation-in-part of application No. 08/582,373, filed on Jan. 11, 1996, now abandoned.

(51) Int. Cl.^{7} **C21D 1/04**

(52) **U.S. Cl.** **148/566**; 148/565; 148/567; 148/572; 148/639; 148/640; 219/635; 219/646

(58) **Field of Search** 148/565, 566, 148/567, 572, 640, 639; 219/635, 646

(56) **References Cited**

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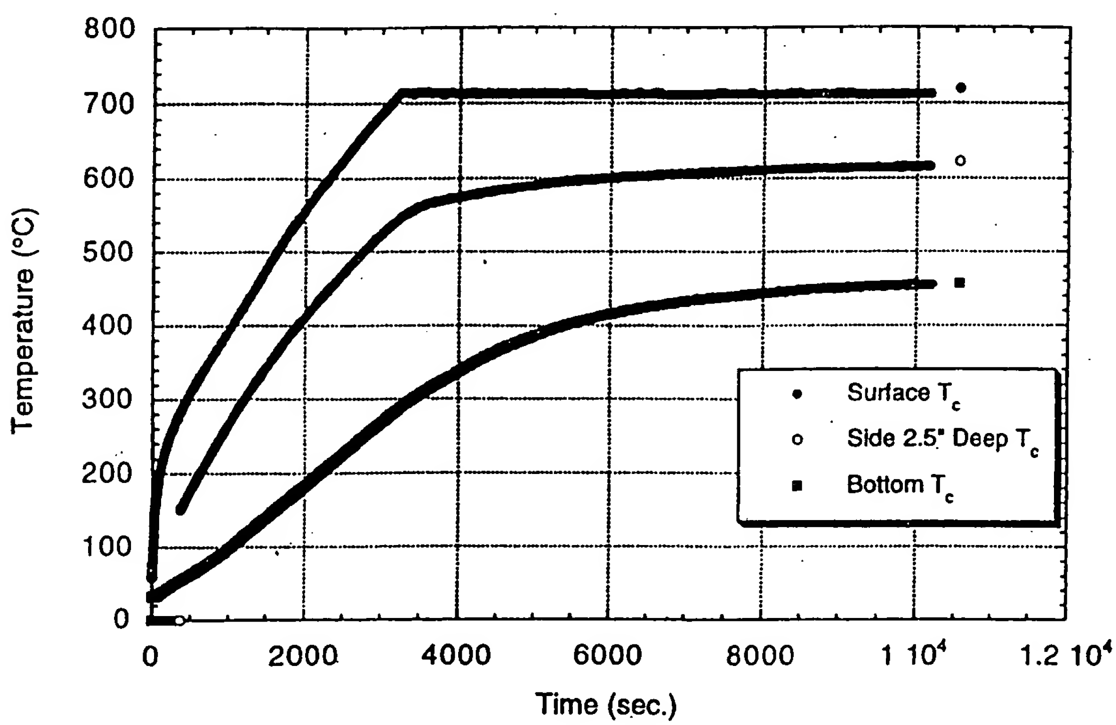
Primary Examiner—Sikyin Ip
(74) *Attorney, Agent, or Firm*—James G. Staples

(57) **ABSTRACT**

A method and apparatus for tempering the shank portion only of die blocks which comprises subjecting the shank portion of a die block or other large metal part to electrical energy derived from induction heating or infrared heating to a controlled depth, preferably just sufficiently deep to temper the shank portion but not sufficiently deep to temper the hardened working portion of the part.

10 Claims, 6 Drawing Sheets



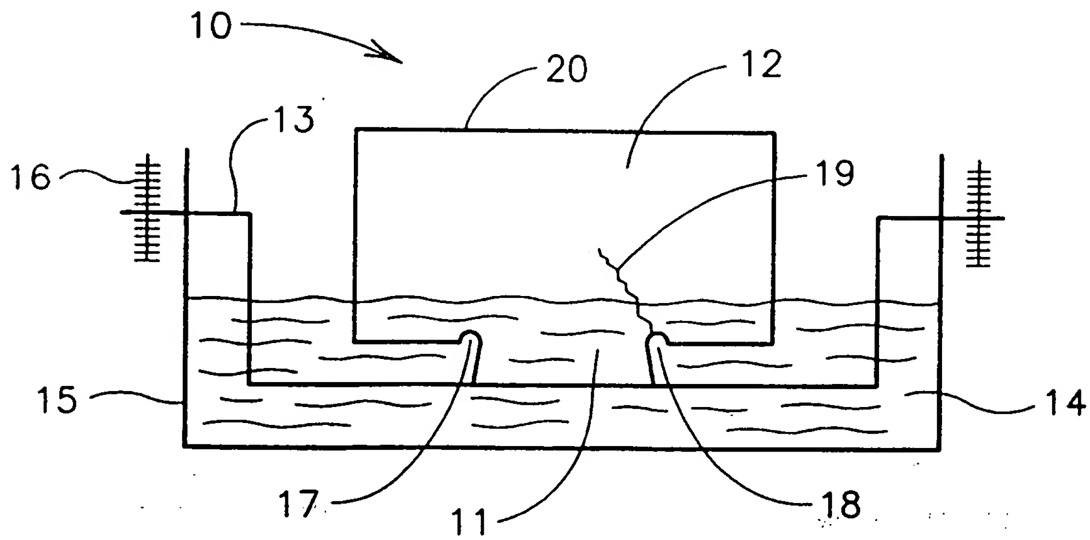


Figure 1
(Prior Art)

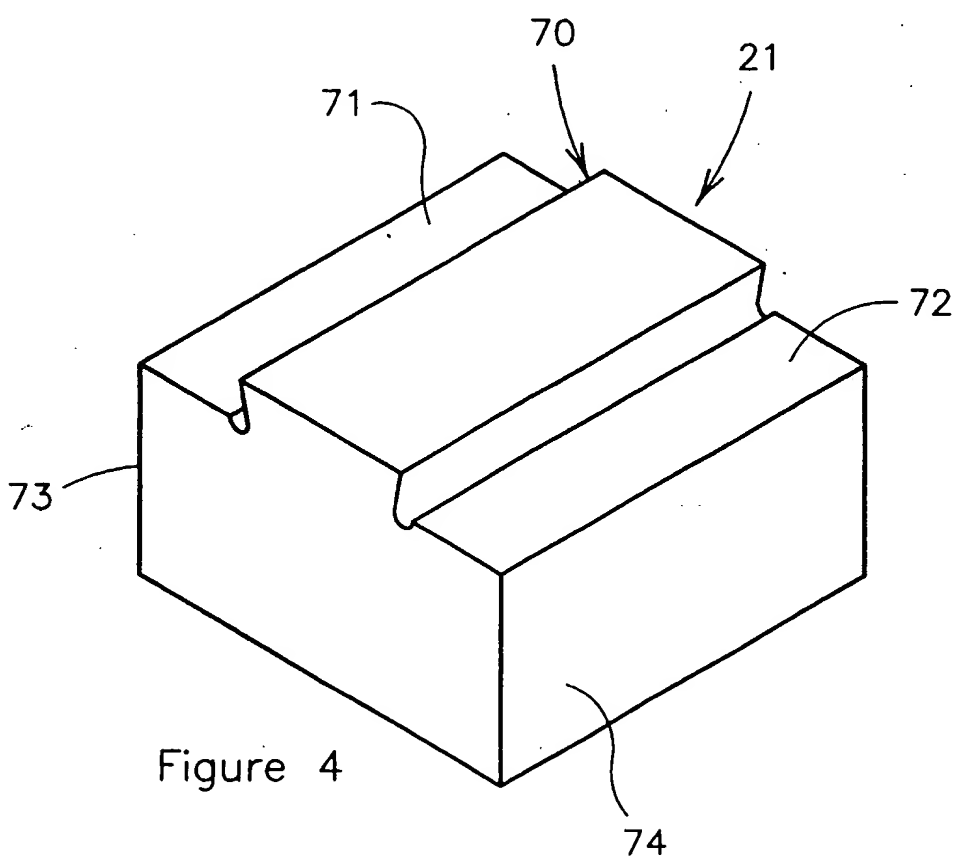


Figure 4

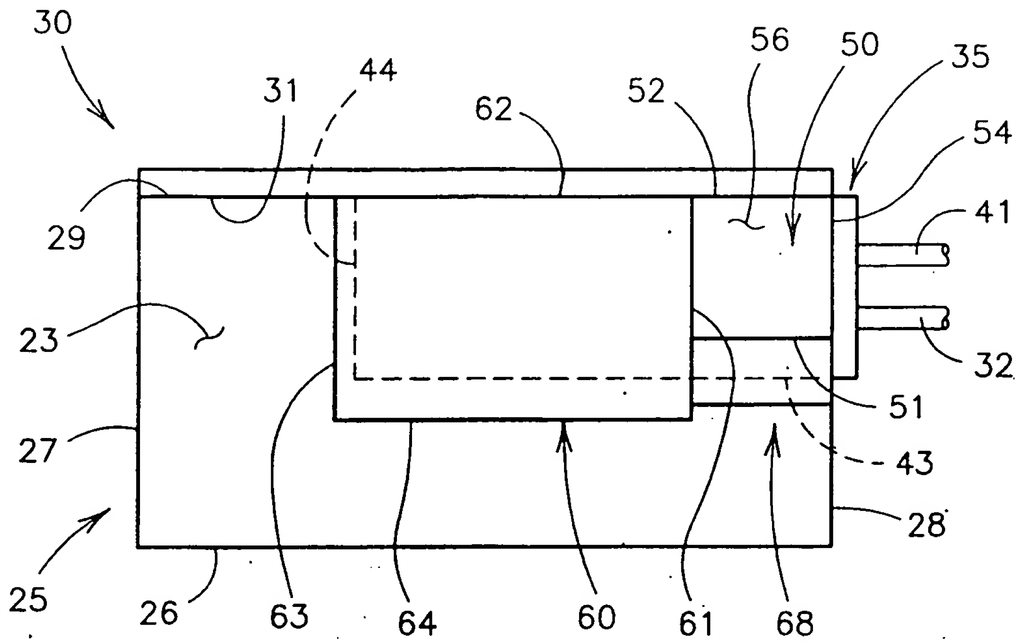


Figure 2

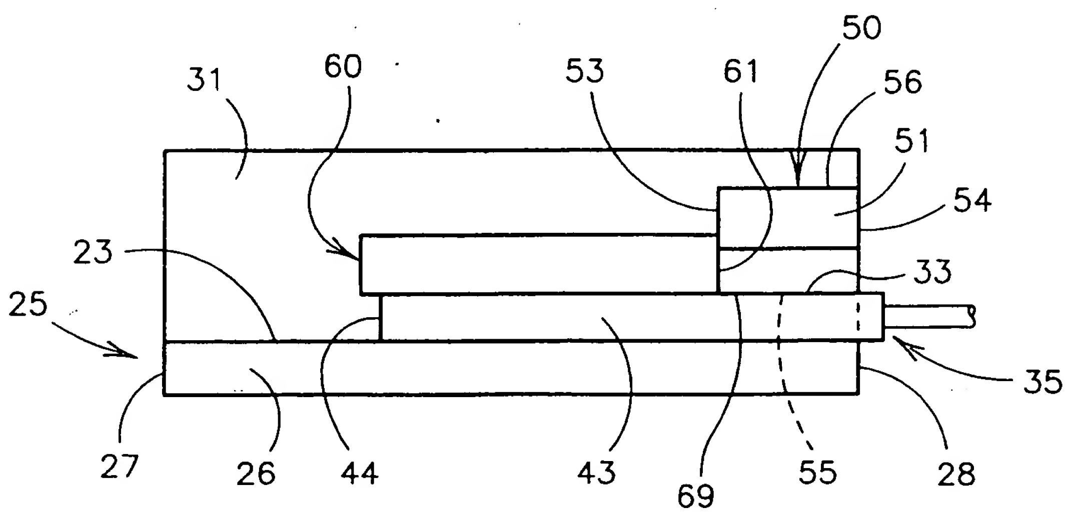


Figure 3

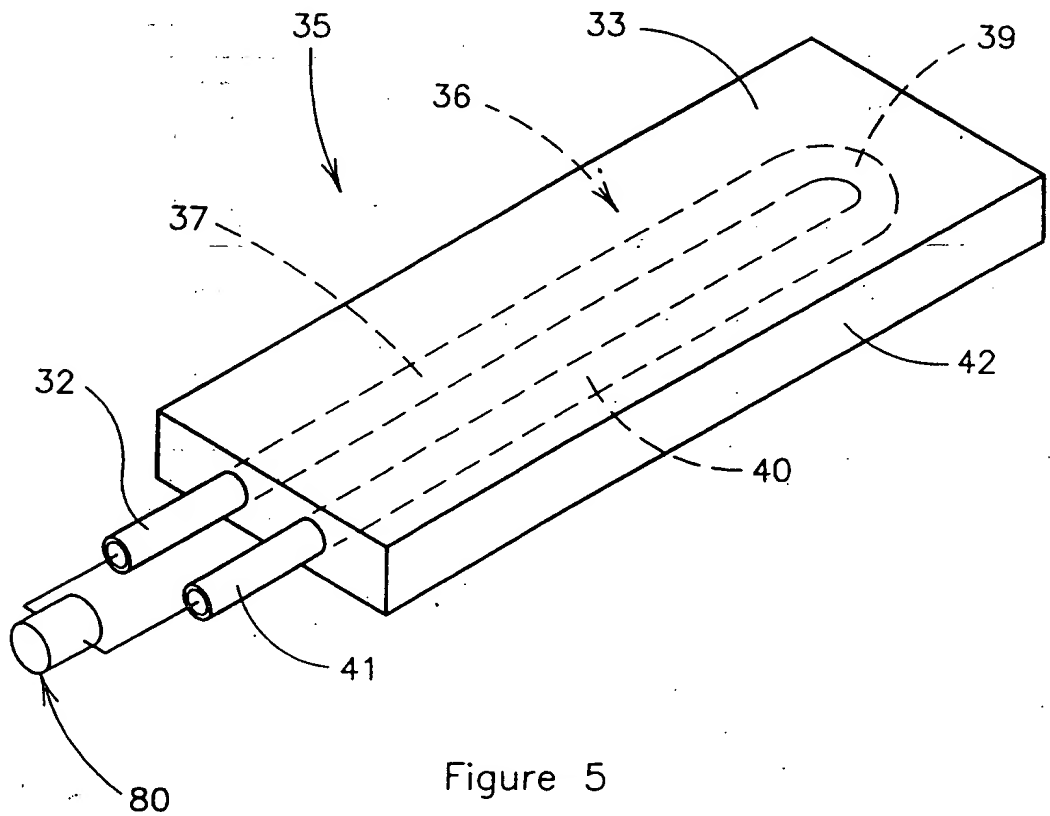


Figure 5

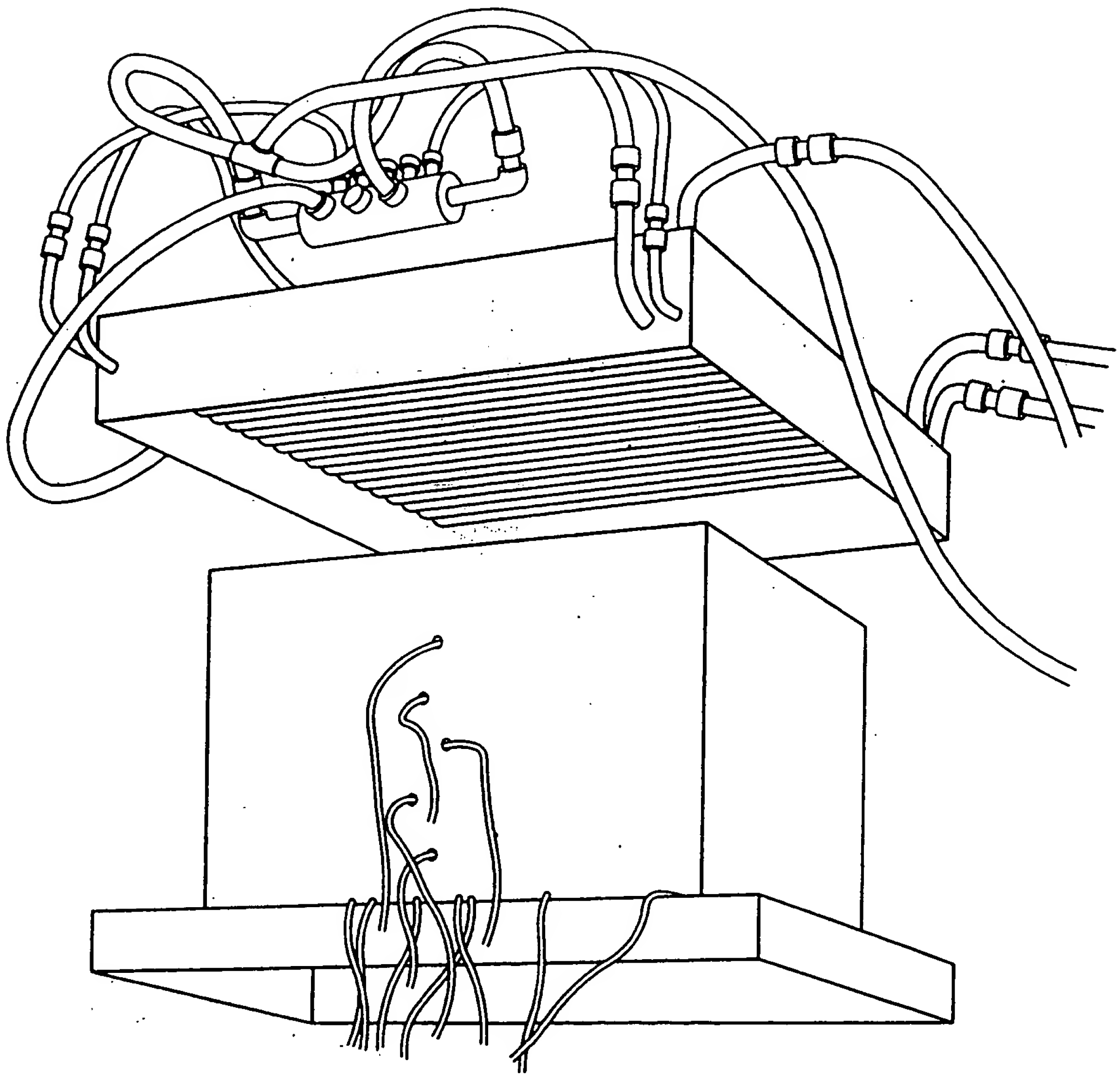


Figure 6

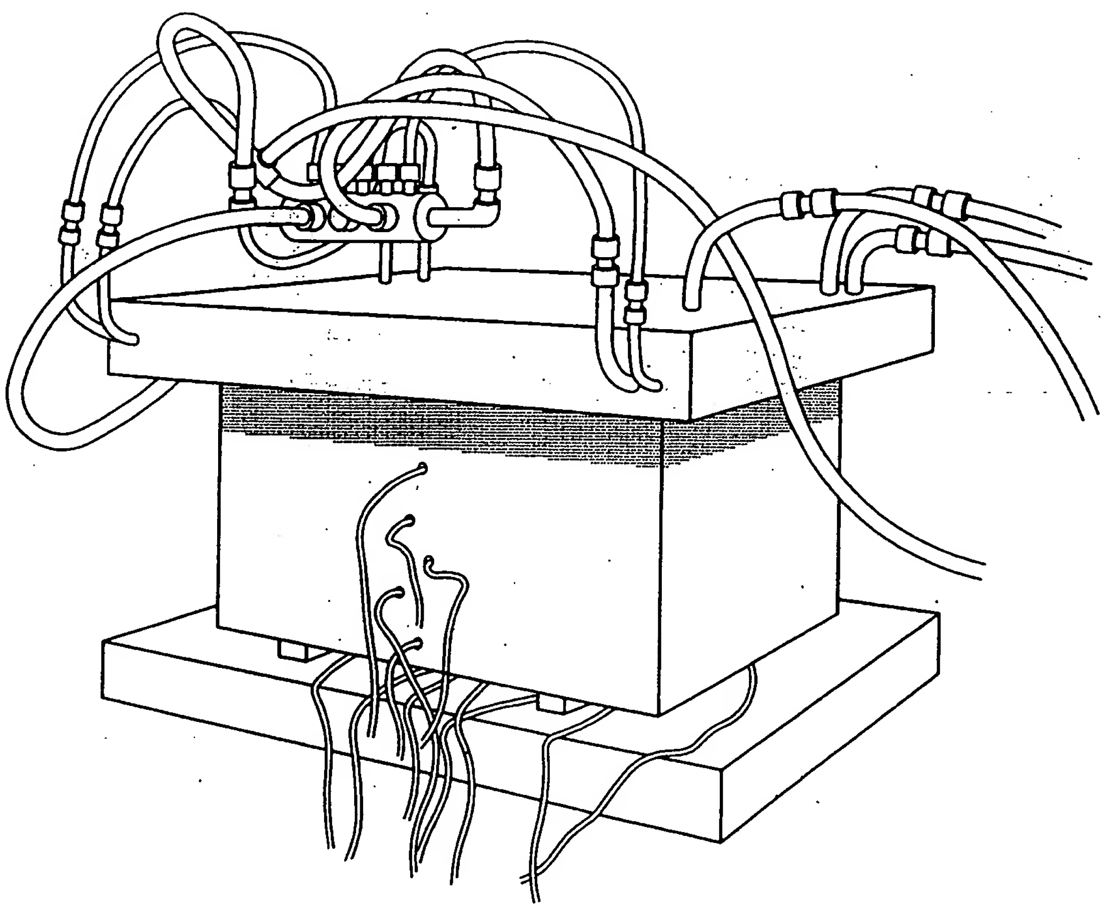


Figure 7

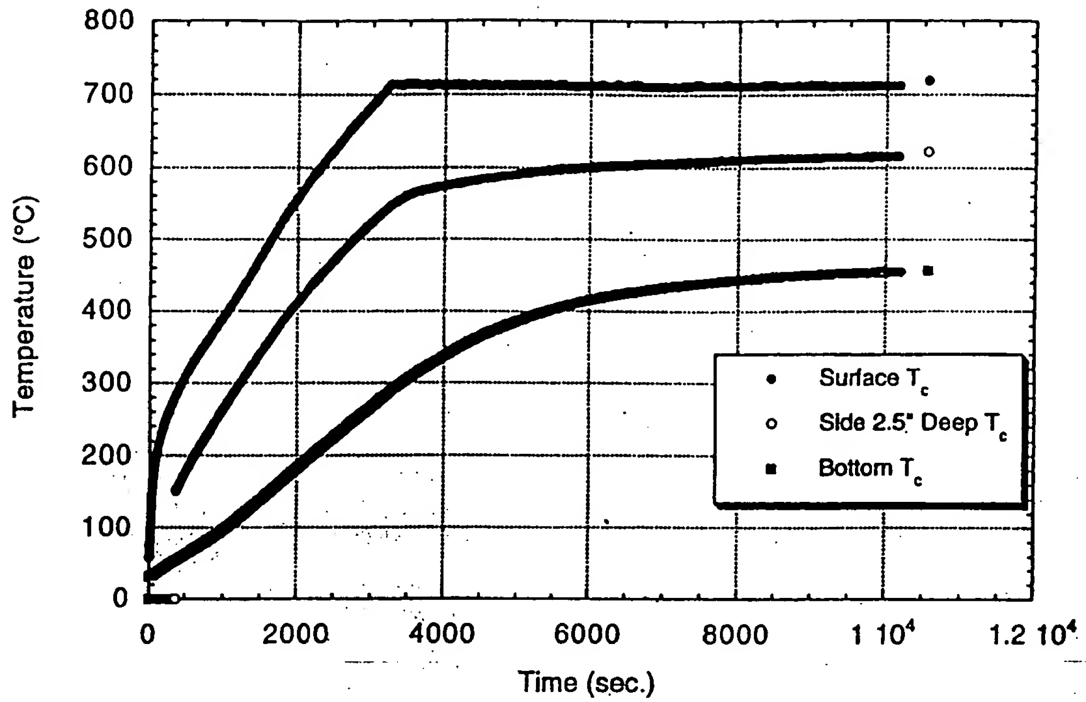


Figure 8

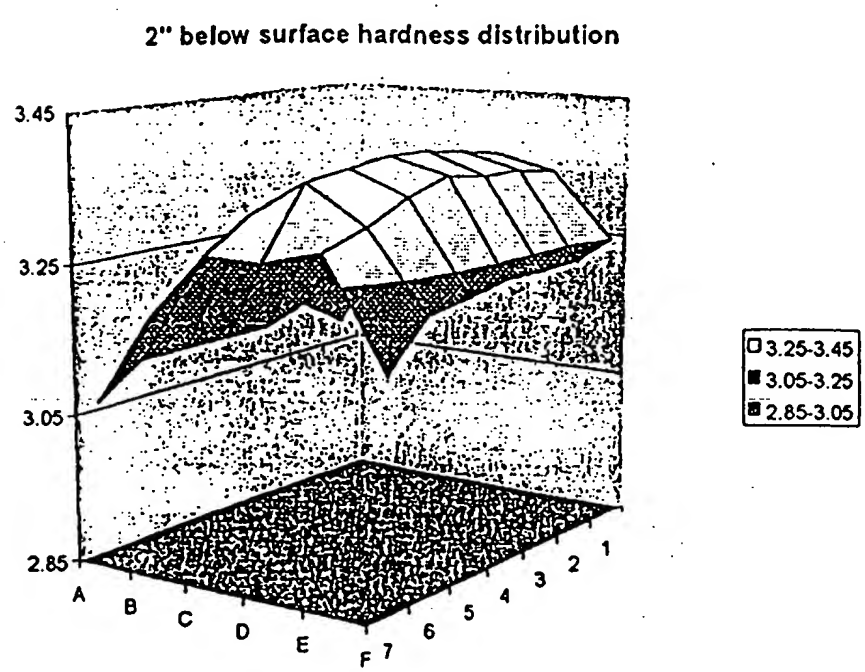


Figure 9

METHOD AND APPARATUS FOR PREVENTING CRACKING OF THE SHANK JUNCTION OF DIE BLOCKS

This application is a continuation-in-part of application Ser. No. 08/582,373 filed Jan. 11, 1996 now abandoned.

This invention relates to a method and apparatus for eliminating or at least drastically reducing the cracking which today frequently occurs at the junctions of the body and shank of ferrous alloy die blocks and similar parts.

BACKGROUND OF THE INVENTION

Die blocks are well known forging implements which, after the sinking of an impression therein to thereby form a die, are used in forging machines such as hammers. A hammer die, after final machining and heat treatment, is then fitted to a die holder in the hammer. A typical hammer die has a large thick body (to provide for one or more resinkings of the impression) and, usually, a relatively short, dovetailed shaped shank located in the middle of one side of the body and extending the length of the body. A typical shank is about 2" in height.

In operation a hammer die is exposed to extremely rugged conditions. In normal operations with all machine components properly positioned and secured, tremendous shock loads are transmitted to all portions of the die. Such loads, which are derived from the many tons of impact forces resulting from the weight of the downwardly driven ram portion of the hammer die striking the workpiece resting in the die holder of the hammer die, have their greatest effect on the weakest portion of the die which, as is well known, is the junction of the shank and body of the hammer die. All too frequently the dies, which may range in hardness from about 28Rc to about 54Rc, are cracked or fractured at the shank-body junction of the die and this can lead to catastrophic failure.

Many forging die applications require a tool steel die block that has been heat treated to a high hardness level to optimize the wear resistance of the working face. At the same time the shank portion of the die block requires a lower hardness level to facilitate machining and prevent cracking of the filet radius during the forging process. The "composite" design is achieved by heat treating the entire block to the high face hardness and then selectively tempering the shank portion at a tempering temperature higher than that used to temper the entire block.

Salt Bath Shank Tempering

In the current practice the shank is tempered by immersing a portion of the previously heat treated and hardened die block into a bath of molten metal salt containing barium chloride ($BaCl_2$) at a temperature of 1250° F. (677° C.). Heat from the molten salt is conducted into the submerged portion of the die block, is transmitted through the block, and is lost through radiation and convection from the portion of the block exposed to the ambient air above the salt. After approximately 180 minutes a steady state heat transfer condition is established where the highest temperature of approximately 1250° F. (677° C.) is present at the submerged corner. The temperature decreases to approximately 1050° F. (566° C.) at the salt immersion depth. The temperature continues to decrease toward the top surface of the die block exposed to the ambient air. The final temperature at the top (working face) of the die block depends on the depth immersion and total height of the die block. It is imperative that the working portion of the die block remain below the original die block tempering temperature to prevent softening of the working face. The metallurgical effectiveness of the shank tempering process depends on the combination of the temperature achieved and time held at that temperature. The current practice specifies a total salt bath treatment of 6 hours (3 hours after steady-state is reached) to allow for sufficient tempering of the shank portion.

Problems with Salt Bath Shank Tempering

Technical, maintenance, environmental, and safety problems limit the commercial success of the current process. Technically the process is limited by the relatively slow rate of heat input generated by the molten salt at 1250° (677° C.). The slow heat input rate coupled with the heat lost due to radiation and convection from the portion of the block exposed to the ambient air limits the maximum temperature within the block, at that salt immersion depth, to approximately 1050° F. (566° C.). The extent to which the shank is selectively tempered is limited by the temperature achieved in the shank portion of the die block and the time held at temperature. The maximum temperature of the top (working face) must remain below the original tempering temperature of the parent block to prevent softening. This maximum working face temperature depends on the depth of immersion into the salt bath (heat input) and the height of the block above the salt bath (heat output). For small blocks it is impossible to sufficiently temper the shank portion without softening the working face due to the relatively small portion of the block above the salt bath. Further the process is somewhat time consuming requiring a batch processing time of six hours. It is possible to increase the effective tempering temperature at the salt immersion depth and decrease the batch processing time by increasing the temperature of the molten salt bath, however, this only increases the maintenance, environmental, and safety problems associated with the process.

Several maintenance problems hinder the commercial success of the salt bath shank tempering process. Costly stainless steel pots are used to contain the molten salt used for the shank tempering process. These pots are corroded by the salt and require replacement approximately every eight months resulting in an annual cost of $5,700. Any increase in salt pot operating temperature will significantly reduce the life of the salt pots. The actual metal salt must be replenished at a cost of approximately $2,000 annually. In addition to the cost of these consumables is the annual cost of approximately $21,000 for the natural gas used to heat the pot. Additional costs are associated with the maintenance of the burners, themocouples, and the control systems.

Several environmental and safety problems plague the use of the salt bath shank tempering process. The barium chloride contained in the salt is considered a hazardous waste under the Resource Conservation and Recovery Act due to its barium content which is a heavy metal and requires special disposal procedures. Overexposure to this salt can lead to several varied health risks. Skilled operators are required to conduct the salt bath processing due to the many safety hazard associated with the molten salt. Extreme care must be taken to avoid the introduction of water into the molten salt. Condensation or ice that may have accumulated on the die blocks will become explosive upon contact with the molten salt if not thoroughly removed prior to immersion in the bath. If moisture is introduced the rapid conversion to steam can splatter the molten salt onto adjacent personnel. Care must also be taken when placing blocks into the salt bath to avoid inhalation of the powdered metal salt when

loading the pot. Because of these environmental and safety concerns it is required that any salt bath tempering process must be located in a specialized shop area.

Following the salt bath treatment the blocks must be stored until cool. Next, the salt that adheres to the sides of the block must be removed prior to the moving the blocks to the next operation. Again this is required to contain the metal salt and prevent contamination of other locations. The same precautions must be maintained when handling the salt that is removed from the sides of the block.

The results of such treatment, while better than no treatment, are, in a sense, marginal since the process is difficult to regulate and measure with precision and a substantial element of judgment enters into the practice of the process, even on a day-in-day-out routine basis. Further, the process is lengthy, often requires the use of cranes or other auxiliary equipment to manipulate, hold and control the position of the die block during the salt bath treatment. The blocks, which are custom made, are of different sizes, shapes and widths, and this non-uniformity makes it even more difficult to properly reduce the hardness at the inside corner of the shank cut-out.

In summary the operating drawbacks to the salt bath system may be summarized as follows:

1. Salt pot has to be replaced twice a year at a cost of approximately $4,000.
2. The salt bath is a toxic waste and disposal is difficult.
3. Salt pot is labor intensive.
4. Salt pot has to be in a special, protected location.
5. Splash and inhalation from the salt is dangerous to the operator.
6. Periodic cleaning is necessary.
7. Salt sticks to sides—has to be washed off.
8. There is a danger of explosion due to the presence of water or ice on the die block.

There is therefore a need for a method and apparatus for preventing, or at least reducing the incidence of, cracking at the shank-body junction of die blocks which is speedy in application, requires minimal handling of the die block to be treated, minimal auxiliary equipment during processing, eliminates the use of hot, liquid salt baths with their above described drawbacks, and gives predictable and duplicatable results over the range of sizes, shapes, and compositions of die blocks currently produced.

SUMMARY OF THE INVENTION

The invention is a shank-body drawing or tempering system utilizing electric heat that eliminates the need for the currently used salt baths with their attendant drawbacks as described above, yet which can process all shapes, sizes and compositions of die blocks in a speedy, efficient and reproducible manner with consistent results, while requiring only a fraction of the cost of capital equipment and operating costs of salt baths, including savings in manpower, space and consumable materials.

In a first embodiment of the invention paddle shaped induction heater means are placed in operative contact with a ferrous workpiece and an enclosure which does not transmit induction currents, said paddle including induction heating coil means having a capacity to heat the critical areas of the die block to any desired depth and any degree of softness using well known operating parameters currently utilized in induction heating devices. Preferably a die block is placed, in a shank down position, on a non-magnetic base and an induction heating paddle is placed in contact with the shank, the exposed portion of the paddle being blocked off with non-magnetic material. The water cooled copper tube induction coil, which is encased in a non-magnetic jacket, is activated for a sufficient period of time, depending on size, shape and composition of the workpiece, to temper the shank-body junction to a condition in which cracking is either eliminated or drastically reduced as contrasted to the results currently achieved with salt baths or other means.

In another embodiment of the invention the die block after hardening but either before or after a shank is formed in the back side (i.e.: the non-working surface) of the die block is subjected to infrared heat. The infrared heat is preferably generated by tungsten halogen lamps which are arranged to direct the radiant energy at the surface to be treated. While no limits on the length of the waves of the electromagnetic spectrum have been positively established, good results have been obtained with short wave radiation, i.e.: 0.78 to 2.0 μm.

DESCRIPTION OF THE DRAWING

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

FIG. 1 is a view of a current prior art salt bath process and system for eliminating cracking at the shank-body junctions of die blocks;

FIG. 2 is a top plan view of the system of the invention showing a die block being treated;

FIG. 3 is a front view of FIG. 4 with parts omitted for clarity;

FIG. 4 is a view of a die block with which this invention may be used, the die block being illustrated in a final machined, shank up position;

FIG. 5 is a perspective, partly diagrammatic view of the induction heating paddle used in the invention;

FIG. 6 is a perspective view, in an open position, of a simple non-insulated infrared furnace utilizing linear tungsten halogen tubes arranged in a rectangular shape corresponding to the shape of the surface of the illustrated die block which is to be softened;

FIG. 7 is a perspective view of the infrared furnace of FIG. 6 in an operating position;

FIG. 8 is an infrared heating profile in a non-insulated furnace with a surface hold at 1320° F. for 3.5 hours; and

FIG. 9 is a hardness profile for an infrared heat treated die block.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of the invention like reference numerals will be used to refer to like parts from Figure to Figure in the drawing.

Referring first to FIG. 1 the current procedure, labeled Prior Art, for reducing cracking at the shank-body junction of a die block is there illustrated. A die block is indicated generally at **10**, the die block having a shank **11** and a body indicated at **12**. The die block is shown positioned shank down on a special basket **13** in a salt bath **14** held in tank **15**. If the vertical dimension of the shank is about 2 inches, which is a conventional shank dimension of ferrous alloy die blocks currently intended for impact forging, such as hammer machines, it will be noted that the depth of the bath is about 3–4 inches, and thus about 1–2 inches of the body **12** of the die block **10** is submerged in the bath **14**. The depth to which the block is submerged can be adjusted as needed by adjustment mechanism **16**. Since the block **10** can be

quite large, for example two feet or more in width together with lengths into double figures, the block represents a very substantial heat sink. As a result, to heat a block, or several blocks if the tank 15 is used to capacity, a large number of calories will be absorbed by the blocks from the hot liquid and hence temperature measuring equipment must be used to continuously monitor the temperature of the bath, and provisions made to add heat to the bath, usually gas burners located beneath the tank. It will be seen that the shank-body junction on either side of the shank has had a fillet formed therein, indicated at 17 and 18. Even with such procedures and precautions, cracking remains a problem. A typical notch crack, as it is called, is indicated at 19. If the crack is severe enough it may extend all the way through to the die face 20 in which event the die is either a total loss or a large amount of rework, including welding and possibly even banding, must be performed, to put the die back into working condition. Even if the crack extends only part way into the body 12 and assuming the operator is alert enough to notice it after it begins, the die must be immediately taken out of production and reworked. Hence down time with all the well known adverse consequences of lost production, are encountered. It should be understood that, more often than not, the block 10 will not have a shank 11 when salt bath treated. A shanked block has been shown for ease of understanding and particularly to illustrate crack 19.

Referring now to FIGS. 2 and 3 a table is indicated generally at 25, said table being composed of a material which does not conduct induction heating currents. A stainless steel or even a granite or suitable ceramic material may be used in the construction of table 25. The table has a front edge 26, left edge 27, right edge 28 and rear edge 29. A backing plate is indicated generally at 30, the lower portion of which, in this instance, is butted against rear edge 29 of the table 25. As can be best seen in FIG. 3, backing plate 30 extends upwardly a substantial distance so that its front face 31 forms an abutment wall of considerable height.

Referring now to FIG. 5 an indication heating means which may be referred to as a paddle is indicated generally at 35. Paddle 35 is an induction heating coil system composed of a length of continuous, hollow copper tubing, indicated generally at 36, said tubing having an inlet 32, an entry run 37, a bend 39, a return run 40 and an outlet 41. The hollow, fluid tight tubing is enclosed in a steel jacket, indicated at 42, whose width and length dimensions can be of virtually any desired measurements and whose height can vary to a considerable extent. It will be understood that the longer the length the greater will be the heat generated, and hence either the greater must be the cooling water flow rate through the tubing, or the larger must be the diameter of the tubing so as to carry enough coolant to remove the heat generated during the process. It will be understood that the paddle may, if desired, be made in two longitudinal sections so that one or more intermediate, mating sections, each with its own length of copper tubing may be added to the paddle to increase or decrease its width as desired, the short lengths of tubing in the added sections being mated to ends of the copper tubing in bend 39. The top face of the paddle is indicated at 33.

Referring now to FIGS. 2 and 3 particularly, the paddle 35 is shown laying flat on the upper surface 23 of table 25, and butted against the front face 31 of backing plate 30 at the table-backing plate junction. The relationship of the front edge 43 and the left edge 44 of the paddle 35 to the backing plate 30 is shown best in FIG. 2.

A through hardened rectangular die block is indicated generally at 50 resting upon the right end portion of paddle 35. The die block, which, in this instance, does not have a shank formed in it, is defined by front side 51, rear side 52, left edge 53, right edge 54 all sides and edges being planar, bottom 55 and top 56. As can be appreciated form FIG. 3, the entire surface area of the bottom 55 of block 50 is in surface abutting contact with the top surface 33 of the paddle 35.

It will be noted that the surface area of paddle 35 is considerably larger in both length and width directions than the dimensions of block 50. In this condition, and in order to ensure efficient operation of the induction heating coil paddle 35, the exposed surfaces of paddle 35 are covered with blocks of material which do not conduct induction heating currents. In this instance a large block 60 is placed on the left end portion of the paddle 35. The right edge 61 of block 60 is placed on the left end portion of the paddle 35. The right edge 61 of block 60 butts against the left edge 53 of the die block and the rear edge 62 of block 60 butts against front face 31 of the backing plate 30. As can be best seen in FIG. 2, the left edge 63 and front edge 64 of block 60 slightly overlap the rear edge 44 and the front edge 43 of the paddle.

A second block, or blocker, is indicated generally at 68. The bottom 69 of block 68 overlies, in surface abutting engagement, the portion of the right portion of paddle 35 which is not covered by die block 50.

It will thus be seen that the surface of die block 50 which is to be drawn is in contact over its entire surface area with paddle 35, and all portions of the upper surface 33 of paddle 35 which are not covered by the die block have been covered by a blocker so that the upper surface 33 of the paddle is not exposed to the atmosphere.

In FIG. 4 the block 50 has been removed following treatment, and a shank 21 machined into the non-working face thereof. Specifically, the shank 21 may, for example, have a width 70 of about 4 inches with the left and right sides thereof having a dimension of about 2 inches, and shoulders, or die wings, 71, 72 of about 10-½ inches; so that the total width of the block is about 25 inches. The vertical dimension of left and right sides 73, 74 may be about 9–11 inches, for example, and the length of the sides 73, 74 may be, for example, 16 inches, though in actuality the length will vary widely; indeed the length dimension of sides 73 and 74 may be of virtually any size, up to and including 8 or 10 feet. Alternatively, fillets may be formed at the shank-body junctions.

By way of comparison, in the salt bath system a rack is usually required for pieces up to about 8,000 pounds during treatment. Above this weight and size tongs, which are controlled by a crane, must be used. As a consequence, for processing which requires a rack the piece dimension should have practical optimum measurements of about 26 inches wide by 48 inches in length by 22 inches in height, with an absolute maximum of about 28 inches wide and 50 inches long. If no rack is used the preferred optimum dimensions are about 38 inches wide by 48 inches long with an absolute maximum of 40 inches wide by 50 inches long. Although the above figures may vary to some degree form installation to installation they illustrate the fact that there is a practical maximum limit to the size dimensions which can be accommodated in the prior art salt bath system.

In operation as shown in FIGS. 2 and 3, when the induction coil is energized, the induction current acts only in the metal components, and specifically only in that portion of the block 50 which overlays paddle 35. A coolant system, including a pump P, is indicated generally at 80 for circu-

lating coolant under suitable and conventional pressures in the copper tubing 32, 37, 39, 40 and 41. The runs of the copper tubing are connected to the power source in a conventional manner. As an example, the application of 60 cycle current for from 15–30 minutes will usually be sufficient to raise the temperature to about 1130° F. in the surface 55 of the block 50, which temperature, while sufficient to adequately temper the eventual shank-body junction area shown in FIG. 4, will not overheat a cavity which has been previously sunk in the die block.

Although a single paddle which, in this instance spans the entire distance between the right side of the body and the shank has been shown, it will be understood that it may be more convenient in other set-ups to use two small paddles.

When the system is not in use, no equipment must be maintained and no special precautions need be taken to ensure the safety of personnel in the area. The paddle 30 will promptly cool down to near room temperature after the power is shut off and the coolant circulated for a few minutes, and the heat pick-up by the large granite nonmagnetic base 25 and the blockers 60, 68 will be minimal.

The infrared energy embodiment of the invention is illustrated in FIGS. 6-9.

Factors of importance in the use of infrared energy are: (1) the absorption characteristics of the material being heated; (2) the power density of the radiating area on the part; (3) the ratio of convected heat to radiant heat; (4) the geometry of infrared emitters and reflectors including furnace design; and (5) the type of control required.

Infrared energy is the portion of the electromagnetic spectrum between 0.78 and 1000 µm. The infrared electromagnetic spectrum can be divided into three divisions: (1) short wave 0.78 to 2.0 µm, (2) medium wave 2.0 to 5.0 µm, and (3) long wave 5.0 µm to 1 mm. The actual emission spectrum of a given source is dependent upon its temperature. Increasing the source temperature will result in shorter overall wavelengths of the energy. This also corresponds to an increase in the overall emissive power. Increased temperature rise of the part can be achieved by increasing the heat transfer, dwell time, or the amount of infrared incident on the target. The wavelength of light utilized in the herein described system, approximately 1.2 µm, will allow for maximum percent emissive power. This wavelength is produced by glowing the tungsten halogen filaments at approximately 4892° F. (2750° C.).

The infrared furnace of FIG. 6 is a cold wall furnace; i.e.: only the work piece is heated to the desired temperature, and the furnace utilizes 100 W per linear inch elements. Due to the low thermal mass of the heating elements, the furnace is capable of its full heat flux in approximately 2 seconds after start-up Also, due to its cold wall design, the furnace cools extremely quickly.

In one demonstration, approximately 12 infrared heat treatments were performed on an 18-×22-×12-in.-thick steel block instrumented with 12 thermocouples located at various depths and locations throughout the block. A maximum of 51.2 kW was utilized on the top surface (22 by 18 in.) of the steel block with an infrared flat panel for 47 minutes prior to cutting back the power to maintain the surface temperature of the block at 1320° F. (716° C.). After 1 hour and 18 minutes, the furnace had to be held at 21.4 kW to maintain the given temperature.

A series of experiments were performed in order to see the effects of several variables, including: (1) surface oxide—(a) unoxidized, and (b) heavily oxidized (i.e.: scale); (2) block insulation—(a) insulating the upper 2.5 in. of the block, and (b) insulating the entire block; (3) edge heating effects; and (4) modeling was also accomplished in order to observe approximate efficiencies.

The block was initially heated with a heavy oxide scale in order to observe the effects of this heavy loose scale on the infrared heating. A second experiment was performed with the surface of the block ground revealing unoxidized steel. It was observed that this had little effect on the overall heating due to a couple of factors. The furnace was positioned over the steel block as shown in FIG. 7 os that any light not absorbed by the block would be reflected back to the highly nonabsorbing body and reflected back to the steel block. The surface of the steel block exceeded 752° F. (400° C.) in less than 10 minutes which is the temperature at which oxidation of the steel will occur and the surface will absorb over 90% of the incident light.

Due to installation of a new multichannel data acquisition system and the need for real time power output of the furnace for modeling, an additional experiment was performed. As can easily be observed in Table 1, the surface of an approximately 1500-lb die block can be brought to the upper tempering temperature in less than 48 min, utilizing less than 52,000 W, and then has to continuously be decreased to 21,000 W to maintain the surface temperature.

TABLE 1

Infrared power flux profile during heat treatment of a die block

Infrared power flux (W)	Time at power flux (min, s)
51,525	47; 40
49,625	2
46,841	1
45,181	1
42,933	1, 50
41,809	1, 10
40,685	2, 40
39,614	2, 10
38,704	1, 50
36,830	2
33,725	3, 10
36,402	4, 20
33,136	10, 30
30,995	7, 20
30,246	8
29,443	9
27,837	3, 30
26,980	22, 50
25,695	5, 20
25,321	1, 40
23,554	15, 10
22,483	49, 10
21,413	31, 50

In a subsequent procedure, a hardened block was treated to preferentially soften the back 2.5 in. Three thermocouples were attached to the block to monitor temperature during the softening process at the surface, 2.5 in. down the side and on the back side. This block was about two-thirds the size of the block utilized for all of the temperature profiling of FIG. 7. The block with a 2.5-in. insulation wrap was heat treated at 1320° C. for 3-½ hours with the infrared furnace, and the temperature profile is shown in FIG. 8.

The foregoing results indicate that infrared sources can effectively reduce the hardness of a prehardened die block. The block hardness was 2.95 BID (429 HB). To verify the softening effect of the infrared heat source, the following procedure was used: (1) 0.5 in. of material was removed, and (2) Brinnel hardness tests were taken over the surface using

a 2-by 2-in. grid. This procedure was performed until the hardness was measured at a distance of 2 in. below the heated surface. As can be seen in FIG. 9, the hardness 2 in. below the surface is an average of 3.26 BID (350 HB). The "crowned" shape of the hardness distribution could be due to the loss of infrared energy from the sides of the block or from the natural hardness distribution from edge to edge of the block.

In conclusion it can be seen that infrared can be readily utilized to preferentially soften die steel to a given depth. Results to date suggest efficiencies on the order of almost 86%. Therefore, combining the fact that the infrared system can be readily turned on and off in seconds and results in no environmental hazards, the infrared system has very considerable cost savings over the conventional salt bath system.

It will thus be seen that a method and apparatus utilizing electrical energy has been disclosed for preventing cracking at the shank-body junction of die blocks which is speedy in application, requires minimal handling of the die block undergoing treatment, eliminates the need for the use of auxiliary equipment during treatment, eliminates the use of hot liquid salt baths with their attendant drawbacks including environmental concerns, and which gives predictable, and duplicatable, results over a wide range of sizes, shapes and compositions of ferrous alloys.

Although a preferred embodiment of the invention has been illustrated and described, it will at once be apparent to those skilled in the art that modifications may be made within the scope of the invention. Accordingly it is intended that the scope of the invention not be limited by the foregoing exemplary description but solely by the hereafter appended claims when interpreted in light of the relevant prior art.

What is claimed is:

1. In a method of conditioning a shank portion of a pre-hardened die block, said pre-hardened die block having a working side and a mounting side, comprising the steps of:

providing a pre-hardened die block having (a) a working surface whose peripheral edges lie in a single flat plane, (b) a shank portion whose exterior surface lies in a single flat plane, (c) the planes of said working surface and said shank portion lying parallel to one another, (d) said parallel planes being located on opposite sides of said pre-hardened die block, and (e) said opposite sides being the working side and the mounting side of said die block,

said pre-hardened die block having a final hardness level including its working surface,

the portion of said fully hardened die block located on the mounting side of the fully hardened die block opposite said working surface having a depth of about two inches extending in a direction from an exterior surface toward said working surface,

treating said two inches deep opposite portion by subjecting it to an electrical source of heat having a temperature higher than the original tempering temperature of the fully hardened die block,

subjecting the remaining portions of the fully hardened die block which are not exposed to the electrical source of heat to ambient conditions, including ambient atmosphere, while said treated portion is subjected to said electrical source of heat,

maintaining the subjection of said opposite treated portion to said electrical source of heat until the original tempering temperature of the hardened die block is exceeded in the said opposite portion and thereby the hardness of said treated portion is decreased to a value below the hardness of the remainder of the die block,

terminating the subjection of said opposite portion to said electrical source of heat after said opposite portion is softened, as contrasted to the fully hardened working surface, to a depth of about two inches below said exterior surface,

whereby the treated portion acquires an easily machineable condition of at least about two inches in depth opposite the working surface, whose initial hardened condition is unchanged, for the formation of a shank.

2. The method of claim 1 further characterized in that the electrical source of heat is in abutting contact with the shank portion of the die block.

3. The method of claim 2 further characterized in that the electrical source of heat is induction heating coil means.

4. The method of claim 1 further characterized in that the electrical source of heat is spaced from the shank portion of the die block.

5. The method of claim 4 further characterized in that the electrical source of heat is infrared heating means.

6. The method of claim 5 further characterized in that the infrared heating means are tungsten halogen lamps arranged to direct infrared energy onto the shank portion of the die block.

7. The method of claim 6 further characterized in that the tungsten halogen lamps operate in the short wave division of the infrared electromagnetic spectrum.

8. The method of claim 7 further characterized in that the wavelength of the tungsten halogen lamps is approximately 1.2 μm.

9. The method of claim 8 further characterized in that the tungsten halogen lamps operate in a cold wall furnace.

10. The method of claim 9 further characterized in that the surface temperature of the shank portion reaches about 1320° F. during treatment.

* * * * *

Attachment 3-2pp

The Making, Shaping and Treating of Steel

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HAROLD E. McGANNON

UNITED STATES STEEL

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even as low as 400 to 700° F, and is thus often the cause of formation of a blue oxide during the cooling cycle.

Hydrocarbons, more specifically methane, are carburizing gases. They are subject to thermal decomposition at annealing temperature, liberating hydrogen and depositing soot on the steel.

The most commonly prepared gases for control of atmosphere are formed by the partial combustion of hydrocarbon gases, contained in such fuels as coke-oven gas, natural gas, propane, or butane. Manufacturers of converters for the preparation of gases describe the various kinds under trade names, such as "DX" gas, "Drycolene," etc. The first step in making such a gas is to burn a mixture of the fuel gas with air. This provides a gas high in nitrogen, but containing other undesirable gases including water vapor, which must be removed. Other atmosphere gases are prepared by (1) cracking a non-combustible mixture of air and gas with a catalyst at high temperature, (2) by cracking anhydrous ammonia at high temperature, and (3) by passing air through a heated retort filled with charcoal.

Furnaces using controlled atmosphere have a number of construction features not incorporated in ordinary furnaces. These features are essential to prevent loss of gas and to minimize the entrance of air into the furnace which would upset the control established. Casings for furnaces with controlled atmosphere are welded gas-tight. Batch-type furnaces are provided with sand seals. Continuous furnaces charged and discharged from the ends sometimes have flame curtains to burn out the oxygen from any possible air infiltration, or the furnace may be operated under sufficient pressure to prevent air infiltration. In the latter case, a small loss of the prepared atmosphere usually occurs through the small unavoidable openings in the furnace. Doors, where required, are fitted snugly by sloping fronts with ground surfaces or by wedging devices or clamps. Modern continuous pusher-type furnaces for special heat treatment of bar and wire coils utilize a vestibule and inner-door arrangement at the charge and discharge ends of the furnace. This permits complete purging of air as material is charged and discharged from the furnace.

Batch-Type Furnaces—The five principal general types of batch furnaces are described below:

1. **Box furnaces** are constructed with a solid hearth. They are shaped, as their name implies, similar to a box and are charged through door openings by tongs or some mechanical charger. The furnace hearth may vary from a few square feet in area to over 30 square feet. Heating may be done by direct or indirect fuel firing or by electricity. Muffle and semimuffle type construction often is employed when control of atmosphere is required. This type of furnace is used frequently for individual-piece or small-lot heat treating, for laboratory test and shop work, and for general production work on a small scale. Box furnaces have been constructed for convection heating either with a fan underneath the roof or with one external to the furnace for recirculation. Furnaces of this type are used for annealing, normalizing, tempering and carburizing.

2. **The car-bottom furnace** consists of a furnace shell equipped with burners or heating units with the hearth built upon a separate car which runs in and out of the furnace shell to charge and unload the furnace. The car usually is moved into and out of the furnace by a toothed rack attached to the bottom of the car and a stationary pinion actuated by an electric motor, the car itself resting on rollers or wheels that move over a two-rail track. The doors of the furnace are of the vertically lifting type, full width of the furnace, and are hydraulically or electrically operated. In order that the entire surface of the charge may be exposed to heat of the same intensity and to aid circulation, the charge is supported above the floor of the car bottom by heat-resisting alloy castings or on refractory piers. The car bottom is made to fit the furnace closely and the escape of hot gases around it is prevented by sand seals. Car-bottom furnaces have been constructed to process charges from a few tons to several hundred tons. They are used for heat treating of axles, bars, heavy plates, castings and miscellaneous shapes.

For operations involving heating, quenching and tempering, it is desirable that the quenching tank be located in proximity to the furnace to enable the charge to be placed in the tank in the shortest possible time. In some installations, less than a minute is required to transfer the charge from a closed furnace to the quenching tank. Car-bottom furnaces may be direct or indirect fired, and various designs have been developed to improve heat distribution in the working chamber. Electric heating also is employed in some car-bottom furnaces. Car-bottom furnaces sometimes are constructed of two chambers side by side, with a common division wall to facilitate annealing and tempering operations. In some installations, an auxiliary cooling system employing blowers is provided to accelerate cooling. Some car-bottom furnaces are known as **elevator furnaces** where the car is rolled under the furnace shell and then raised into the furnace by a motor-driven lifting mechanism. Those in which the shell is lowered over the car, as shown in Figure 39—46, are used to provide a more complete sand or water seal than is obtainable with the conventional car-bottom furnaces.

3. **The bell-type furnace** has a removable shell or cover. The furnace usually is used for processing material which requires special surface protection from oxidation or decarburization. The furnace shell is removed by a crane and set aside while the hearth of the furnace is charged. The shell is then replaced, as was shown in Figure 39—44. Furnaces of this type, used for annealing sheet, strip, rod and wire, usually are called **box annealing, pack annealing, coil annealing, or cover annealing furnaces**. In these, the material is stacked on a permanent base or stand, a light inner cover is placed over the stack, sealed with sand at the bottom and provided with a constant supply of prepared gas atmosphere, and then the portable heating unit is lowered over the assembly. The heating covers are square, rectangular or cylindrically shaped. Loads vary from 35 to 400 tons per charge, distributed on one to eight stands per base. In most instances, a number of bases and inner covers are provided with one or more covers for heating. After heating of each charge

Attachment 4

15. In a method of heat treating rod, bar and block tool steel workpieces the steps of

providing a heat treatment furnace of a size suitable to receive a tool steel workpiece to be heat treated,

providing a heat source in the interior of the furnace consisting of a source of infrared heat energy,

subjecting the tool steel workpiece to heat treatment by exposing said tool steel workpiece to infrared heat energy from the infrared heat energy source and

maintaining said tool steel workpiece stationary during subjection of the workpiece to heat treatment from the infrared energy source.

6. The method of claim 15 further including the step of

providing a ceramic or other high melting point support structure to support the tool steel workpiece.

7. The method of claim 15 further including the step of

providing an air atmosphere in the furnace.

16. In a method of heat treating a rod or bar or block tool steel workpiece the steps of

providing a heat treatment furnace of a size suitable to receive tool steel workpiece to be heat treated,

providing a source of infrared heat energy in the interior of the furnace consisting of tungsten halogen lamp means,

subjecting the tool steel workpiece to heat treatment by exposing said tool steel workpiece to infrared heat energy from the tungsten halogen lamp means and

maintaining said tool steel workpiece stationary during subjection of the workpiece to heat treatment from the infrared energy source.

17. The method of claim 16 further including the step of

generating a temperature of up to 5000°F in a tool steel workpiece located in close proximity thereto from the tungsten halogen lamp means.

Attachment 5

Re: 183-U.S.

Claim 1 - U.S. Patent 6,398,885

1. In a method of conditioning a shank portion of a pre-hardened die block, said pre-hardened die block having a working side and a mounting side, comprising the steps of:

providing a pre-hardened die block having (a) a working surface whose peripheral edges lie in a single flat plane, (b) a shank portion whose exterior surface lies in a single flat plane, (c) the planes of said working surface and said shank portion lying parallel to one another, (d) said parallel planes being located on opposite sides of said pre-hardened die block, and (e) said opposite sides being the working side and the mounting side of said die block.

said pre-hardened die block having a final hardness level including its working surface.

the portion of said fully hardened die block located on the mounting side of the fully hardened die block opposite said working surface having a depth of about two inches extending in a direction from an exterior surface toward said working surface.

treating said two inches deep opposite portion by subjecting it to an electrical source of heat having a temperature higher than the original tempering temperature of the fully hardened die block.

subjecting the remaining portions of the fully hardened die block which are not exposed to the electrical source of heat to ambient conditions, including ambient atmosphere, while said treated portion is subjected to said electrical source of heat.

maintaining the subjection of said opposite treated portion to said electrical source of heat until the original tempering temperature of the hardened die block is exceeded in the said opposite portion and thereby the hardness of said treated portion is decreased to a value below the hardness of the remainder of the die block.

terminating the subjection of said opposite portion to said electrical source of heat after said opposite portion is softened, as contrasted to the fully hardened working surface, to a depth of about two inches below said exterior surface.

whereby the treated portion acquires an easily machineable condition of at least about two inches in depth opposite the working surface, whose initial hardened condition is unchanged, for the formation of a shank.